THIRTY-THIRD ANNUAL REPORT

SECRETARY

Massachusetts Board of Agriculture

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Mass: State board of agriculture.

THIRTY-THIRD ANNUAL REPORT

OF THE

SECRETARY

OF THE

Massachusetts Board of Agriculture,

WITH

RETURNS OF THE FINANCES OF THE AGRICULTURAL SOCIETIES,

FOR

1885.

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STATE BOARD OF AGRICULTURE, 1886.

Members ex officiis.

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His Honor OLIVER AMES.
Hon. HENRY B. PEIRCE, *Secretary of the Commonwealth.*
CHARLES A. GOESSMANN, *State Agricultural Chemist.*
JAMES C. GREENOUGH, *President Massachusetts Agricultural College.*

Appointed by the Governor and Council.

	Term expires.
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Chosen by the County Societies.

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Massachusetts,	E. F. BOWDITCH of Framingham,	1888
Massachusetts Horticultural,	E. W. WOOD of Newton,	1888
Middlesex,	JOHN B. MOORE of Concord,	1888
Middlesex North,	A. C. VARNUM of Lowell,	1889
Middlesex South,	S. B. BIRD of Framingham,	1887
Nantucket,	R. E. BURGESS of Nantucket,	1888
Plymouth,	ELBRIDGE CUSHMAN of Lakeville,	1887
Union,	S. A. BARTHOLOMEW of North Blandford,	1889
Worcester,	C. L. HARTSHORN of Worcester,	1887
Worcester North,	EDWIN A. GOODRICH of Fitchburg,	1887
Worcester Northwest,	J. P. LYNDE of Athol,	1889
Worcester South,	BAINBRIDGE DOUTY of Charlton,	1889
Worcester West,	J. HENRY GODDARD of Barre,	1887

JOHN E. RUSSELL,
Secretary.

THE

THIRTY-THIRD ANNUAL REPORT

OF THE

SECRETARY

OF THE

BOARD OF AGRICULTURE.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

The year 1885 was favorable to our most important crops. It was a remarkable summer, in that we were spared our usual experience of drouth, except in Plymouth, Barnstable and Dukes. In these south, seaward counties, the season was dry and unproductive.

Several successive years of severe drouth had weakened all our grass lands and shortened the crop of hay, which is the chief reliance of our husbandry. The injury to the grass roots had compelled the restocking of large areas that were in great need of moisture, and the favorable season was of advantage that will be felt in the years to come. The season was especially good for corn, — a crop in which our farmers have lately renewed their former interest. Many thrifty managers believe they can raise corn, with our present estimate of the value of stover, cheaper than it can be

purchased from the West, and improve the fertility of their lands for following crops.

A large proportion of our cattle are now fed upon corn fodder, in place of hay, and the product of the grass lands is sold in the towns.

The preservation of green fodder in silos is followed to a considerable extent, but with much modification of the original teaching, which was derived from French sources and unsuited to our climate and our crops. The extravágant claims made by early enthusiasts have been modified in the school of experience, and there is now but little difference in the opinions of practical men. We have proved that good material, fairly mature in growth, can be made into ensilage and conveniently kept for future use, and that immature and watery green crops are not increased in value by keeping in a silo.

The gladly received assertion that ensilage alone was a support for cattle has now no supporters. It is found that the limit of value of the best ensilage is soon reached, and that it is only a convenient adjunct in feeding. The experiments of individuals, and the earnest discussions of the institutes, of the county societies and farmers' clubs, have been of far-reaching consequence in teaching the potentiality of land fertilized and tilled to the utmost to produce both the grain and stover of corn, and incidentally these experiences have led us to a concentration of capital and effort upon fewer acres.

In making a money crop of our hay, we find that the price in the towns is regulated by baled hay imported from Canada. In the year ending Jan. 1, 1885, there was imported 160,950 tons of hay, which paid a duty of two dollars a ton, about 15 per cent. of the current value of hay in our markets. This competition kept the market price far below what it would have been if hay paid duties in proportion to the taxes collected on salt, sugar, iron, and other necessaries that we buy with the money received for our hay.

In the same year the price of eggs, the farmer's constant resource for cash, was regulated by the importation of 16,098,450 dozens entirely free of duty. Of this enormous

quantity, about 14,000,000 dozens were brought in from Canada; 955,550 dozens from Belgium; 631,250 dozens from Denmark; 310,161 dozens from Germany; 48,380 dozens from Sweden and Norway, and smaller quantities from other distant regions of the earth. But for these importations our farmers would have had more money to pay taxes and buy protected merchandise.

The large number of farmers producing milk for Boston have had a hard year. Unremitting labor, rigorous economy, and a decline in the value of their farms, must be the result of their labors for the past twelve months. The business is controlled by contractors. Fortunately, Western grain has been cheap and we have had no prevalent diseases among our cattle.

Our usually safe and prosperous husbandry in swine has been much disturbed by Hog Cholera, a disease of Western origin, very fatal, infectious, and continually maintained by importations of hogs from the West. It has caused much annoyance and loss all over the State. The report of the Cattle Commissioners, printed in another part of this volume, refers to their work in dealing with this disease.

Sheep husbandry continues to decline. A new reason may be given for this condition in the unremunerative price of wool that has caused the slaughter of great numbers of Western sheep, glutting our markets with mutton. When flocks were profitable, the constant danger from dogs made the business distasteful, as few flocks escaped their licensed ravages. At present, with threatening dogs and low prices for wool and mutton, this business is without encouragement.

Butter making has been fairly profitable; the competition of spurious butters has not been felt by our best dairies and probably does not materially affect the market price of carefully made butter. The present tendency is to establish creameries where skilful dairymen are employed and a uniform quality of product is secured.

The use of commercial fertilizers is greatly increasing; farmers well understand their efficacy, convenience, and relative cheapness compared with natural manure. These questions have been constantly presented for discussion at our

institutes and meetings for years; the annual report of the State chemist giving the value of each composition offered in our market, whether made in the Commonwealth or brought in from other States, is eagerly sought and read in every village.

The fertilizers, advertised here and sent to buyers from other States, thus avoiding our license law and the close inspection of our chemist, are dangerous merchandise for our farmers to buy; such goods are without guarantee of value and may not be worth the cost of transportation. The report of the State chemist, published in this volume, should be the farmer's guide, and the goods of all manufacturers who do not conform to our law, and who are afraid of a published analysis, should be avoided.

The State Experiment Station has been doing valuable work. Its report, by a law of the last legislature, was made a public document, and consequently cannot hereafter be published in this volume. For the same reason, I am compelled to omit the annual report of the Agricultural College.

The important topic of Forestry has not been neglected at our meetings.

The aggregate of polls, property and taxes in the Commonwealth, in 1885, shows the numbers of live stock as —

Number of horses,	151,994
" " cows,	167,817
" " sheep,	56,240
" " neat cattle other than cows,	57,044
" " swine,	44,670

There has been an increase, since 1884, in the number of horses of 2,307.

There has been a decrease in the number of cows of 733.

There has been a decrease in the number of sheep of 5,707.

The total numbers of neat cattle other than cows, and of swine, were returned last year by the assessors for the first time, under the provisions of chapter 106, Acts of 1885.

The annual fairs of the chartered societies receiving the bounty of the Commonwealth were successful and interest-

ing, several of them recording the largest attendance in their history.

The lectures and discussions herewith printed are upon topics of especial interest. The lecture by Mr. Potter upon farm law is published by his permission, he reserving the right of republication.

JOHN E. RUSSELL,
Secretary.

PUBLIC MEETING OF THE BOARD

AT

FRAMINGHAM.

PUBLIC MEETING OF THE BOARD AT FRAMINGHAM.

COUNTRY MEETING.

The country meeting of the Board was held at Framingham, December 1st, 2d and 3d, and was well attended. Mr. S. B. Bird, President of the Middlesex South Agricultural Society, called the meeting to order at 10.30 A. M. on Tuesday, December 1st, and spoke as follows: —

OPENING ADDRESS BY S. B. BIRD.

Gentlemen of the Board of Agriculture, — A year ago to-day the Middlesex South Agricultural Society, at its annual meeting, by a unanimous vote, invited you to hold your next country meeting in this place. You having accepted their invitation, it now becomes my pleasant duty, in behalf of the society, to extend to you a cordial welcome. We welcome you as the representatives of the agricultural interests of this Commonwealth; we welcome you knowing that you are authority on all matters pertaining to agricultural science; and we welcome you because we expect to derive both pleasure and profit from your deliberations.

In greeting the members of the Board to-day, I miss from our number the genial member of the Plymouth Society. He was with us at our last annual meeting, active and interested, and was elected a member of the committee of arrangements for this meeting; but during the past summer he was taken from us. I trust at some future time you will take suitable action in regard to his services and memory.

While we are enjoying our meeting here to-day, in a distant Western city the last sad rites are being observed of the late Vice-President of the United States, and although we may not feel his loss so keenly as those more nearly con-

nected with him, yet we join with the millions who to-day mourn the Nation's loss.

It is customary, gentlemen, at the opening of the country meeting, to present some account, historical and statistical, of the place where the meeting is held. Fortunately for us, we have with us a gentleman, native-born and a life-long resident, who has been engaged in preparing a history of this town for publication, and who has very kindly prepared a paper for this occasion. I now have the pleasure of introducing our town's historian, the Rev. JOSIAH H. TEMPLE.

ADDRESS OF REV. JOSIAH H. TEMPLE.

Mr. Chairman, and Gentlemen of the State Board of Agriculture, — It is my most agreeable duty, in behalf of our citizens, to bid you welcome to Framingham.

And we congratulate you, and felicitate ourselves, that you found access to our town so easy. The railroads come to us from the North and the South, the East and the West. The Boston & Albany and its branches reach from the State metropolis to the Berkshire hills, and the Old Colony and its connections from the New Hampshire line to the South shore.

And these facilities of travel, it is obvious to say, are not only a means of comfort to those who come and go, but they are an important factor in our local prosperity. The Boston & Worcester Railroad, which was opened from Boston to Framingham in 1834, and to Worcester the next year, was the making of our now flourishing South Village. So that from a dozen dwelling-houses, one cobbler, two blacksmiths, one store, one tavern, one cider-mill, one slaughter-house, and the bonnet manufacture which could be carried on in two not very capacious private sitting-rooms, the village has grown to be a commercial centre, with two savings banks, one National bank, five churches, five schools, two newspapers, many stores and mechanics' shops, large manufactories of straw goods, rubber goods, boots and shoes, a population of about 3,000, and an annual business of over $2,000,000.

And our Centre Village, where you are now met, — with a present population of 1,000, five churches, six schools, one

National bank, four stores, and the relative number of mechanical trades, — in the year 1800 was mostly covered with the primitive forest, and then contained one meeting-house, two school buildings, two taverns, two stores, and less than half a dozen dwelling-houses. It was waked into active life by the opening of the Boston and Worcester turnpike, built in 1809. And the transformation was so sudden that in less than ten years we had representatives of all the common trades and professions; and the rattling of nine daily stage-coaches over the highway, and the blast of the driver's horn among our hills, only echoed the hum of busy life at the Centre.

Our picturesque village of Saxonville owes its existence to its excellent water-power, and its established business brought the railroad to its door, rather than the railroad brought the business. In the year 1800, the place had two grist-mills, one saw-mill, two fulling-mills, one store and two cobblers; in 1880, it had three churches, six schools, numerous stores and shops, a population of nearly 2,000, and a manufacturing industry amounting to over $1,000,000.

And to revert to still earlier times: it was an *Indian trail* crossing our territory, that first brought this town to the knowledge of the whites. And it happened in this wise: — In the fall of 1630, Governor Winthrop's colony, which had arrived in the spring, fell short of provisions. News of the scarcity reached the ears of the Indian sachem who lived in what is now Woodstock, Conn., accompanied with the intimation that the English would pay a good price for corn. The hillsides of Woodstock were famous for their bountiful corn crops; and the old chieftain, from his full stores, filled large sacks with the precious commodity, and with his son and other Indians carried the heavy burdens on their backs to Boston. Whether our boasted "Yankee enterprise" is an original trait, or is only a copy of this *Indian enterprise*, is too broad a question for present consideration.

And it should be added, that this Indian trail, running diagonally through our territory, and thus brought to light, was followed by the early English explorers, and by Messrs. Hooker and Stone and their large company that migrated from Cambridge to Hartford in 1636; and became what is

known in history as the "Old Connecticut Path," which was the travelled way from the Bay to the Connecticut River, for the next forty years.

Framingham is the youngest of the group of towns that form the nucleus of the Middlesex South Agricultural Society. Sudbury, which included Wayland, and is the "mother of us all," was founded in 1637. The settlers were attracted there by the rich and extensive meadows, which then furnished abundant and most nutritious grass and hay for their cattle, but are now sadly deteriorated. This town led all the others in this part of the county, in population and in valuation, till 1710.

Natick was originally organized as an Indian town in 1651, and was not incorporated as an English town till 1781.

Marlborough, which included Southborough, Westborough and Northborough, was made a plantation in 1656. The Sudbury people were attracted there by the great Indian cornfield, which they coveted, and some excellent grass lands lying southerly of the present village; but the real origin of the town was a quarrel — perhaps I ought to say, difference of opinion — among the Sudbury men about the division, taxation and pasturage of a piece of "common land." The legislature undertook to heal the sore; but the question in dispute got into the church, and to save the church, and at the same time to cut the Gordian knot, the legislature granted to what was called "the aggrieved party," a tract of land six miles square, and made it into a new town.

Sherborn, which included Holliston, was made into a township in 1674. The main attraction to settlers was the excellent meadows lying on Charles River, near which the first comers pitched.

Framingham lands began to be granted by the legislature as early as 1640; a settlement was made within our limits in 1647; but the place was not recognized as a plantation till 1675, and was not incorporated as a town till 1700. As originally laid out, the plantation contained 20,500 acres. Of this, 500 acres was set to Hopkinton; Holliston took a small slice; Southborough took 300 acres, and Marlborough took the northwest corner; and later, Ashland has received 3,000

acres; and we have received a small triangle from Natick; leaving the present area of Framingham 15,930 acres. Of this, 715 acres were covered with natural ponds and streams; 340 acres have been set apart for highways; and the city of Boston has seized for the use of the Sudbury River System of Water Supply, about 900 acres. The State muster grounds, agricultural fair grounds, five town cemeteries, two commons, and other exempt lands, comprise 194 acres; making a total of 2,150 acres, to be subtracted from the whole area, and leaving 13,780 acres subject to taxation. The population of the town is 8,275. We have expended within the past six years $38,700 for new schoolhouses; our annual grants for schools average $22,000; and our grants for repairs of highways, $8,500; but we take a little pride in the fact that the average rate of taxation for the past ten years has been only $9.85 per $1,000. We can also boast that we owe no debt except to our own town funds.

Framingham has been from the first a farming town. Indeed the earliest name of the plantation was "Mr. Danforth's Farms." It was so called from the fact that the largest part of our territory, viz., 14,000 acres, was granted by the General Court to Thomas Danforth, deputy governor of the Province, for services rendered and £10 in money advanced for the benefit of the colony. And the rest of our lands were laid out by the legislature into farms varying in size from 80 acres to 960 acres, — excepting a tract of 2,000 acres on the easterly side of the river, which was bought of the Indians by private parties.

The system of *mixed farming* has prevailed among our people from the first. The inventory of the stock and produce of one of our 100-acre farms, dated 1676, — 210 years ago, — shows 17 head of neat cattle, 2 horses, 8 sheep, 27 tons of hay, 13 bush. of wheat, 50 bush. of rye, 260 bush. of Indian corn, some flax and hemp, and 600 pounds of pork.

One hundred years later, Framingham town had 200 families; owned 1,000 head of neat stock, 162 horses, 886 sheep, 35 swine; and raised 20,600 bush. of grain, and made 1,500 tons of hay.

One hundred years later still, our Framingham farms kept

stock as follows: 1,200 head of neat cattle, 480 horses, 323 sheep, 675 swine; and raised 30,000 bush. of Indian corn (average 40½ bush. per acre), 275 bush. of wheat, 2,500 bush. of rye, 3,000 tons of English hay and 2,700 tons of meadow, and 41,500 bush. of potatoes; and sold 88,646 gallons of milk and 48,229 pounds of butter.

And it is in place here to say, and your Board will be interested to know, that the business of dairying and corn-raising has been greatly stimulated by the settling among us of men of abundant means, and large information, and cultivated taste, who have introduced and tested improved breeds of cows, and improved methods of tillage, and shown the possibilities of high farming, and the making of first-class butter. "Fancy farming" may not pay, either as an investment or an example; but intelligent farming, directed by the same forecast and energy and *esprit de corps* that succeeds in in other callings, always pays. We have learned how to raise corn and make butter; and if the State Board of Agriculture will *settle* the question, How to renovate our worn-out pasture lands, — we promise that when your Board shall come to us again, in our turn, we will show you a long list of rich farmers and a remarkable dairy record.

Apple orchards were early planted in this town. Jethro, the Indian, had an orchard in bearing in 1675, and some of the trees were standing within my remembrance. In 1760, about 2,000 barrels of cider were made. One hundred years later, we had 30,768 apple trees, and in addition to the grafted fruit, sold to the value of $16,000; there was made from the refuse and native apples 2,000 barrels of cider, most of it for refining and a foreign market.

Pears were formerly cultivated to a considerable extent in this town; twenty years ago 2,000 trees were reported, but the culture has decreased. Of the smaller fruits, our grape crop, raised for the market, once amounted to 17,000 pounds a year, but is now much less. We have raised for sale as many as 3,300 quarts of strawberries per annum, and probably now raise that quantity.

Within a few years market gardening has become an important industry in Framingham, and is found to pay well.

Like other communities we have some things to grumble

about. Our peach crop has been a failure; the apple crop brings unremunerative prices; we have canker worms, and potato bugs, and hog cholera. But we shall not inflict our troubles and disappointments upon you. Most of our clouds have silver linings, and there are many things in which we feel a special pride. In closing, I will enumerate some of them.

We think we have a right to be proud of our educational advantages. The State Normal School occupies a commanding local position, and holds a prominent place in our beneficent influences. It is open, free, to our daughters and to your daughters alike. Our system of graded schools — 28 in number — puts an education in the reach of all our children. We have expended not less than $60,000 in school buildings, and this year the town granted $22,950 for the support of schools, equal to $16.62 per child of school age. And not the least among our means of a higher and broader education is our Free Public Library, largely the gift of our public spirited citizens, especially of Col. Moses Edgell, who left the sum of $47,000, the income of which is to be expended for its maintenance and enlargement. Number of volumes on its shelves, 11,281.

And it is natural for us to boast of our ample Town Funds, amounting to the sum of $92,300. The chief of these are the Edgell Library Fund, $47,000; the Cemetery Fund, by the same donor, $10,000; the Phipps Poor Fund of $20,000, left by George Phipps, the annual income of which is to be distributed by the selectmen, for the benefit of deserving poor, at their homes, and which is proving to be a most blessed charity.

We call your attention to our tasteful public buildings, our churches, schoolhouses, and especially to the State Normal School and Memorial Hall, the latter dedicated to the use of our Public Library and to the memory of our soldiers who fell in the Great Rebellion. We ask you to notice particularly our commodious and good-looking *farm buildings*. An unsightly farmhouse and cold barn and piggery are the exceptions to a general rule with us. The stables of to-day are more comfortable for man and beast than the kitchens,

which were the family living-rooms of our farmers, were in my boyhood.

We are proud of our thrifty and well-fed stock, in the barn; but we are more proud of the healthy and helpful wives and children, in the house.

We hope it may be your convenience and pleasure to become acquainted with them all.

THE CHAIRMAN. For several years past the cultivation of the potato, especially as an early market crop, has received considerable attention in this vicinity, and the first paper is upon the culture of the potato, by Mr. EDMUND HERSEY of Hingham.

POTATO CULTURE.

BY EDMUND HERSEY OF HINGHAM.

So much has been said and written on the subject of potato culture, that it would seem to be a waste of time to bring the subject before you; but a little reflection leads to a different conclusion, for the potato furnishes a food which is found on the tables of all classes, therefore every individual has a direct interest in the dissemination of that knowledge, which will secure the production of it in the highest state of perfection, at the least possible cost. There are so many important points that are yet in dispute, even among the most intelligent, practical farmers, that every cultivator should make an effort to contribute some information, fresh from the field of practice, that will tend to settle some of the numerous points of disagreement. Looking at the subject in this light I feel justified in bringing before you the results of my investigations and experiments during the past thirty-five years.

In making the investigations and conducting the experiments I have tried to keep in mind, what is too often lost sight of, namely, the fact that we do not plant the true seed, but the tuber.

There is a great difference between a seed and a tuber. A seed is a single germ of life, made up of materials that are composed of two incomplete life germs. A tuber is a number of life germs, made up from a material furnished by a single matured life.

A seed being derived from two lives, as a rule partakes of the characteristics of each, and is very rarely if ever precisely like either; in fact, it is the creation of a new life slightly different from any which has preceded it. The tuber, being derived from one life, partakes of all of the characteristics of it, and in fact is but the renewal of the old life. The germ of a seed is furnished with but a very limited amount of substance to support it in its first stages of growth, and this amount is very nearly the same in different seeds from the same plant, so that when two are planted side by side their resources for early growth are very nearly alike; the germ of a tuber is furnished with a large quantity of substance to force the new plant, and there is a great difference in the amount of this substance which is available to the different germs, and this difference can be increased by the arts of man; for example, a large potato may have all the eyes but one cut out and thus planted, and by the side of it might be planted an eye without any potato attached to it. Thus one germ would start life with a very large quantity of plant food to force its growth; the other, having none, would have to depend entirely on the soil for substance.

Every intelligent gardener has learned by practice, that if he would secure vegetables of the highest type of excellence, he must plant seeds produced from specimens that approach the nearest to his ideal of perfection, not only in color and flavor, but also in size and form. This is so well established, that it may be considered the one point in agriculture that is well settled. As the potato is the only vegetable in general cultivation that is not propagated from the true seed, it is very naturally considered by many cultivators as subject to the same laws as other vegetables; so we often hear intelligent, practical farmers declare, that the size and form, as well as the quality of potatoes, can be changed by the selection of the desired form to propagate from, and it is asserted by some that the planting of two varieties in the same hill will cause them to mix and produce a new variety; but the number who hold to these opinions is every year decreasing.

A very large number of cultivators are firm in the belief

that the stem or large end of the potato is much better to plant than the seed or small end, and that by continuing to plant only the stem end a great improvement can be made in the size and quality of the potato, while the seed end will in a few years be reduced in size and injured in quality.

It is the general belief that while small potatoes may be planted one or two years with good results, if continued a few years the product will be only small potatoes. Being one of the believers in this theory, I resolved to enter into a series of experiments to prove beyond the possibility of a doubt the correctness of it. For six years these experiments have been going on. The work has been done under my direct supervision. In planting, the small potatoes were not planted in one row and the large ones in the next, but, to make sure that there should be no difference in the treatment, small potatoes were planted in one hill and large in the next, and so continued through the entire experimental plot. To make sure of an equal weight of the large and small seed, a specified number of small potatoes, about an inch in diameter, were weighed, and the same weight of large potatoes were cut in as many pieces as there were small ones. At harvest time all the hills planted with small seed were first dug, then assorted, and the small ones weighed separate from the large ones, and a record made of the whole product. The seed was then selected for the next planting, boxed and marked; then the hills planted with seed from large potatoes were dug, assorted, weighed, and the large ones for the next planting selected, thus keeping each year the products of the two sizes separate, so that the potatoes which this year came from small potatoes are from the same stock that came from small potatoes planted the first year.

In presenting to you the results of this experiment, I confess it is not what I had expected, or what the public would naturally expect it to be, but I am not here to prove the truth of my own theories, or those of the public, but to lay before you the results of carefully tried experiments, which are as follows: —

YEARS.	Small Seed.		Totals.	Large Seed.		Totals.
	Large.	Small.		Large.	Small.	
1880, . .	30¼ lbs.	8¼ lbs.	38½ lbs.	24 lbs.	10 lbs.	34 lbs.
1881, . .	27 "	13 "	40 "	26¼ "	8¾ "	35 "
1882, . .	18 "	9 "	27 "	77½ "	10 "	27½ "
1883, . .	33¾ "	8¼ "	42 "	34¼ "	11¼ "	45½ "
1884, . .	33¾ "	7½ "	41¼ "	36¼ "	11¼ "	47½ "
1885, . .	31 "	5 "	36 "	23¼ "	9 "	32¼ "
Totals, .	173¾ lbs.	51 lbs.	224¾ lbs.	161½ lbs.	60¼ lbs.	221¾ lbs.

The small seed produced 12¼ pounds more of good potatoes than the large seed, and 9¼ less of small potatoes. To secure a permanent record, after six years' trial, that will reach the eye, when the potatoes were dug, each hill of one row was kept separate, packed in boxes, and numbered in the order in which they grew; a portion of these have been taken to a photographer, arranged as they grew, showing each hill side by side, and photographed.

It was my intention to have had the tops photographed at two periods of their growth, but not being able to get a photographer at the proper time, I was compelled to abandon it; this is to be regretted, for I am sure it would have interested you to have seen the very great difference between the tops that came from the small seed, and those that came from the large seed. When the tops from the small seed were full grown, the tops from the large seed were not more than two-thirds grown, and when the tops from the small seed were entirely dead, the tops from the large seed were quite green; the difference in the time of ripening being about ten days. The cause of this I believe to be the loss of vitality in the cut potato, by exposing its interior to the air, thus drying up the juices, and weakening its power to force the growth of the young plant. Experiments prove that when a cut potato is covered with plaster, or some other material that in a measure shuts out the air, the young plant will come forward wtih more vigor, than if the potato be left uncovered.

It is intended to continue this experiment four years longer, making ten years from the beginning. If the small potatoes continue to produce as good potatoes as the large, it will be fair to presume that there is but little danger that the continued planting of small potatoes will cause them to run out.

The second experiment, commenced in the year 1881, was to test the qualities of the two ends of the potato, the seed or small end being planted in one hill, and the stem or large end in the next, and so continued through the plot. When the crop was harvested the potatoes were kept separate, assorted, weighed, and a record made, the seed for the next year selected and boxed, care being taken to keep the potatoes that grew from the seed end separate from those that grew from the stem end, so that each year the seed from the stem end should come from potatoes that grew from seed of the stem end, and the same with the seed end.

The result each year was as follows: —

YEAR.	SEED END OF POTATO.		Total.	STEM END OF POTATO.		Total.
	Large.	Small.		Large.	Small.	
1881, . .	21½ lbs.	6½ lbs.	28 lbs.	13½ lbs.	6½ lbs.	20 lbs.
1882, . .	28 "	8 "	36 "	38 "	2 "	40 "
1883, . .	32¼ "	6¾ "	39 "	20¼ "	9 "	29¼ "
1884, . .	32¼ "	6¾ "	39 "	20¼ "	9 "	29¼ "
1885, . .	27½ "	6¼ "	33¾ "	27¾ "	6½ "	34¼ "
Total, . .	141½ lbs.	34¼ lbs.	175¾ lbs.	119¾ lbs.	33 lbs.	152¾ lbs.

The seed end produced $21\frac{3}{4}$ pounds more of good potatoes than the stem end, and $1\frac{1}{4}$ pounds more of small potatoes.

The seed end has always come forward earlier than the stem end. When the tops come to their full growth there appears to be from a week to ten days' difference, and it has been my opinion that seed from the seed end of a potato would ripen a crop at least one week earlier than seed from the stem end; but on a very careful examination this year, continued until the crop was fully ripe, I am led to doubt the correctness of my former belief, which was based upon

examinations that were continued only until the tops were fully grown. To my surprise this year, I found that after the tops were fully grown, those that came from the stem end rapidly gained on those from the seed end, so that when the tops began to change color and ripen, there was but very little, if any, perceptible difference between the two. Whether this has always been so I am not able to say, because, unfortunately, my daily examinations, before this year, have ceased when the tops had become fully grown. In the future, daily examinations will be continued until the crop is fully ripe, that this point, which is an important one, may be settled. That the results of this experiment may be preserved so as to reach the eye, photographs of the potatoes in the order in which they grew have been taken.

My next experiment was made with seed potatoes after they had grown sprouts from four to six inches in length. One portion was very carefully handled, so as not to injure the sprouts, and was planted so that a portion of the sprouts were above ground after the seed was covered; the other portion of the potatoes had all of the sprouts rubbed off before planting. The result of this experiment was so remarkable that I am led to believe that the experiment should be continued several years, before conclusions of any great value can be drawn. The result of this trial was twice the quantity of potatoes from the seed that had the sprouts left on, as compared with those that had their sprouts rubbed off.

Several years ago an experiment was tried to test the difference between seed that had been kept and planted on my farm for ten years, and that obtained from Nova Scotia. The result the first year was nine bushels of potatoes from the Nova Scotia seed to five from my own. The experiment was continued the second year by again purchasing seed from Nova Scotia. The result was nine bushels from the seed purchased to six from my own. What makes the result of this experiment more remarkable, is the fact that it was tried with the full belief that my seed would produce the best crop; this belief being based upon the fact that I was getting better crops from my seed than many others were from purchased seed. Many other experiments have been tried, particularly in methods of planting and cultiva-

tion, but to give the details would occupy more of the time of this meeting than would be advisable; besides, the result of each experiment depended so much on the character and condition of the soil, and the state of the weather, that the most successful results, if copied, might under different conditions prove failures. This is the rock upon which we all split; each successful cultivator settles down to the methods that he finds, in his practice, to be the best for his particular farm, and knowing them to be the best for him to follow, he very naturally thinks them superior to all others for general adoption. So when two or more practical cultivators meet, each will be very likely to insist that his methods are the best, and as it is very rare that any two methods are exactly alike, those who attend the meetings to gain practical information, listen to a multitude of opinions, and go back to their farms more than ever in doubt as to the best method of growing potatoes.

This difference of opinion is an honest one, and grows out of the fact of the great difference in surrounding conditions, which are overlooked. A and B experiment to ascertain the proper quantity of seed to plant on a given quantity of land. After years of careful experiments, A settles down to the conclusion that a small quantity of seed is the best; in fact, that single eyes, with but a very small piece of potato attached, secures a crop of the largest and best potatoes. B, after making equally careful experiments, covering quite as long a period, comes to the conclusion that a large quantity of seed — in fact, that large whole potatoes are the best, and will argue in favor of heavy seeding. Now, if A and B had visited each other's farms and carefully examined the conditions under which each experiment had been tried, they would have at once seen, that while they were both right, they were also both wrong. They would have seen that while the method which A had adopted was best for his farm, it would not do at all for B to adopt it. Why? Because the soil of the farm where A planted his potatoes was not only very rich naturally, but it had also received large quantities of fertilizers, in a state to be immediately available for plant food, and the soil being thoroughly pulverized, it was so completely filled with available

plant food, that the moment the little rootlets started from the single eye planted, they were fully supplied with all the nourishment they could take; thus a vigorous growth was forced directly from the soil, independent of any nourishment received from the potato planted.

The soil in which B planted his potatoes being naturally deficient in plant food, and the manure applied being in a state which required considerable time to change to plant food, the rootlets, when they started from the eye of the potato, could gather but very little nourishment from the soil, because it was not there in a form to be available, so the plant must wait until the manure applied has so decomposed as to furnish the soil with plant food; thus the plant starts feebly, and never fully recovers. But if the rootlets be attached to a whole potato, failing to get a full supply of nourishment from the soil, they very readily draw from the substance of the potato, which is well adapted for the forcing of a vigorous growth; and by the time the potato is exhausted, the fertilizer applied will be so decomposed as to fill the soil with plant food, and the roots of the young plant will have become wide-spread enough to gather substance sufficient to keep the plant vigorous, and mature a good crop. If A had planted a large potato on his soil, it would have been lost, because the plant has readily drawn its food from the rich, thoroughly prepared soil, without drawing from the potato. This I have seen, and sometimes the potato thus left unconsumed will keep perfectly sound until autumn.

In cultivation, very much depends on the character of the soil; there are some soils on which a large crop of potatoes cannot be obtained by the hilling process, and there are, also, soils which will not produce large crops by level culture. The drier the soil, the more important is it to adopt level culture. On a wet soil, the potatoes should be planted on the surface and the hilling process commenced when the seed is covered; but on a dry soil the potatoes should be planted so deep that, when covered, the top of the covering will be below the surrounding level. This gives room for the hill to form below the level of the land, and gives room for the potatoes to grow beneath the surface.

Every cultivator should adopt that method of cultivation which he finds best adapted to his soil, and not that which is recommended by some successful cultivator whose soil may be entirely different.

My experience with the potato scab has not been very satisfactory. The first two years' trial seems to prove that the scab was carried from the old seed to the new potato. The scabby potatoes planted produced a crop much more scabby than those planted; but the next year, which was last year, the scabby seed produced potatoes quite as free from scab as did the seed that was not affected by the scab.

One experiment was tried last season which was not what was intended. Having ordered ten pounds of ground bone and twenty pounds of muriate of potash to be applied to two rods of land on which was to be planted one-half peck of scabby potatoes, through a mistake ten pounds of ground bone and twenty pounds of nitrate of soda were applied. The result was remarkable. The land was a dry sandy loam. The tops during the first part of the season made a wonderful growth, but the hot July sun changed the color of the portion where the soda was spread the thickest, it not being spread even; but at harvest time the crop was found to be large and the potatoes of the very best quality, being perfectly smooth and free from scab, although every potato planted was scabby. Perhaps I ought to state that when it was found that a mistake had been made, about a half a pint of wood ashes was applied to each hill at the first hoeing. Whether the good crop was caused by the application of so large a quantity of nitrogen, or whether it grew in spite of it, further experiments must determine. Large quantities of nitrogen have never been supposed necessary or beneficial for the growth of the potato.

Most of the experiments which I have tried have been tried on land in ordinary condition, and the amount of manure applied only sufficient to produce a fair crop. In the trial of large and small seed, and in that for testing the difference in the two ends of the potato, a rich soil and heavy manuring was avoided, because the desire was to have the trial made under conditions such as would usually be found in common farm culture; possibly, in fact, proba-

bly, if the same experiment be tried on a very rich soil, heavily manured, the result would be different.

My experience and observation lead me to the following conclusions: —

First. The shape of a potato cannot be changed by the continued selection of any particular form of the seed planted.

Second. The crop may be increased by selecting for seed healthy, well-kept potatoes, and diminished by selecting diseased and poorly kept potatoes.

Third. Hard potatoes that have sprouted but little, are better for seed than those that are soft, or that have long sprouts.

Fourth. Long continued planting of any variety gradually changes its character, often improving it during the first twenty years after it comes from the seed; it then frequently begins to lose its good qualities, and to become more susceptible to disease.

Fifth. Large crops are only obtained on rich soils, well prepared by being thoroughly pulverized.

Sixth. In ordinary field culture the size of the potato planted should be sufficient to give the young plant a vigorous start; whole potatoes, or pieces, weighing from one to two ounces, are not too large.

Seventh. Neither the size nor the form of the potato, for seed, is of half so much consequence as its healthy condition and its vital powers.

Eighth. No rules can be laid down in regard to the quantity of seed per acre, the amount of manure to be applied, or the particular method of cultivation, that will apply to all farms.

Ninth. One or a half-dozen experiments are not sufficient to establish any particular facts; it is only by numerous experiments, covering a long period of time, and tried on different farms, that we can arrive at satisfactory results.

Tenth. While the successful cultivator may gather from others much valuable information to assist him in his investigations, if he would produce large crops at the lowest possible cost he must rely principally on the practical

experience which he has obtained by working on his own farm.

Mr. Bowditch. Were the large potatoes cut to a single eye or cut in the old-fashioned way?

Mr. Hersey. The seed was cut so as to have two eyes in a piece.

Question. Was the small seed cut?

Mr. Hersey. The small potatoes were not cut at all; they were planted whole; but the piece of cut potato was precisely the same weight as the whole small potato. The idea was to ascertain, if possible, whether there was any difference between a small potato and a large one in planting it. The small seed produced twelve and one-quarter pounds more of good eating potatoes than the large seed, but nine and one-quarter pounds less of small potatoes.

Mr. Ware. Will you please tell us how many sprouts grew and matured of the small potato? You say there were two eyes on the pieces cut from a large potato; how many sprouts would grow and make mature stalks?

Mr. Hersey. Two. I did not allow but two. If I had allowed more, I should not have had a fair trial.

Mr. Varnum of Lowell. I would like to ask Mr. Hersey if he would recommend planting the same piece twice with potatoes?

Mr. Hersey. As a rule I should not; and yet you can raise good potatoes twenty years in succession on the same land, if you treat your land with the object in view. I speak from experience. I should not recommend any one to do it. I should say that one crop of potatoes for a farmer to grow on the same land is sufficient.

Mr. Varnum. Would the quality of the potatoes be as good the second year?

Mr. Hersey. I really do not see any difference in mine. I think my potatoes are pretty good where they have been planted over twenty years on the same land.

Mr. Paul of Dedham. Would you recommend sward land or old land that had been cultivated before?

Mr. Hersey. That depends very much upon the condition of the soil. On some soils I would recommend sward

land; on others, I should not. I could not on my farm do as well on sward land as I could on land that had been planted one year to corn, because my land is light. I suppose it is on account of the fact that the sward is loosened up so that it is drier the second year than it is the first. The wetter land would do better.

Mr. Paul. Would you recommend ploughing in the fall and spreading manure in the fall?

Mr. Hersey. On the sea-coast we do not plough as much as you do in the interior. On the sea-coast the ground lies uncovered with snow, and the result is, if we plough in the fall, we lose a great deal of the fertilizing qualities of the soil. For that reason we do not consider it best, as a rule, to plough in the fall, unless it be for some particular purpose. If it is rough land, that we are going to cross-plough in the spring, we sometimes plough it in the fall and then cross-plough it in the spring; the idea being that the loss by turn ing it open to the air will be more than compensated by the pulverization of the land.

Question. What do you lose in the value of your land by ploughing it in the fall?

Mr. Hersey. The wind takes off the finest soil from the top, especially on land that is dry.

Question. Don't you think the potato is more free from scab on old land than on new land?

Mr. Hersey. My experience in regard to that was precisely contrary, and I was surprised at it. I ploughed a piece of land that had never been planted before. It was a swamp, where one would naturally expect to get potatoes of the best quality; but they were really hardly fit for market.

Mr. Ware. Have you in your observations fixed in your own mind the cause of the scab, whether by an insect or by fungus?

Mr. Hersey. I do not know any more about it than you do.

Mr. Ware. It was stated a year ago, that it was a little insect, which could not be seen with the naked eye, but could be seen with a microscope.

Mr. Hersey. I am all at sea in regard to the scab. I don't know half as much about it as I thought I did last year.

Mr. ———. Among the experiments tried by the French soldiers on St. Helena, when they were taking care of Napoleon, they experimented with potatoes, and they got the best results by planting them eight inches deep; if they did not plant them so deep, they could not get such good crops.

Mr. HERSEY. If I could see the soil, perhaps I could guess what the reason was. I am driven to the necessity of putting potatoes on my land very well down, or I should get light crops. I have to adopt level culture simply because repeated experiments have proved to me that by hilling I cannot get half a crop.

Mr. VARNUM. I believe it is a popular idea among the farmers in my vicinity that in order to raise a good quality of table potatoes they should be planted on new ground. What is your opinion on that point?

Mr. HERSEY. I have just stated that I planted half an acre of land that had never been planted before, — for a hundred and fifty years, at any rate, during which time it had been in our family, — and some of the potatoes were very inferior. I suppose the reason was that the land was too wet. Probably it was not ripe enough; it had not been planted enough. The next year, if I had planted potatoes, perhaps I might have got better ones. There is some new land which undoubtedly produces better potatoes than old land. Old land, where the forest has been cut off and a considerable portion of it burned on the land, filling it full of potash, is where the potato delights to grow, and where it will undoubtedly come to as full perfection as anywhere else.

QUESTION. Have you tried enough fertilizers to satisfy yourself which is the best fertilizer for potatoes?

Mr. HERSEY. I can tell you what I use; perhaps it would not do at all for your land. I use either ashes and ground bone or muriate of potash and ground bone for my potatoes.

Mr. VARNUM. Do you put them in the hill?

Mr. HERSEY. I put them in the hill, but I spread some on the ground. I do not believe in depending entirely on manure in the hill. You can start the crop a little in that way. I scatter a little along the rows and harrow it in.

QUESTION. Don't you ever use any barnyard manure?

Mr. HERSEY. I use a little. I do not make very much

on my farm. We keep four or five cows, but the manure does not amount to much. I have to buy something, and I found out sometime ago that I could afford to apply a commercial fertilizer, provided I could make it myself. I don't know whether I could afford to buy it or not. We make our own fertilizers.

QUESTION. How far apart do you put your hills of potatoes?

Mr. HERSEY. About forty inches. I plant them in hills, five hills to a rod.

QUESTION. How far apart are the rows?

Mr. HERSEY. They are square each way.

QUESTION. Have you ever experimented in regard to planting in hills and drills? If so which will produce the most?

Mr. HERSEY. The drills will produce the most, but it is more work for me to care for them. I do not make a business of raising potatoes. My work is a great deal of it experimental. I use the common cultivator, the "Planet Junior," and I want to run it both ways. If I plant potatoes in rows, it increases the expense so much that I prefer to plant them in hills; but undoubtedly those who have the proper machinery, and who grow large quantities of potatoes, will get more potatoes by planting them in rows, and perhaps do the work quite as easily.

QUESTION. Do you have the potato rot in your place?

Mr. HERSEY. We have not been troubled very much with the potato rot. We had some of it four years ago, but apart from that we have not been troubled at all with the potato rot.

QUESTION. Do you have any potato bugs?

Mr. HERSEY. We have a few; they are a nuisance, and yet the bug has taught the farmer to treat his potato crop a good deal better than he ever did before. He does not run over as much land as he formerly did, because he has found out that it does not pay as well; and looking at it in that light, I am not sure that the potato bug has done much damage.

QUESTION. Have you settled in your experiments whether

or not it will do to plant a choice variety of potatoes a number of years in succession?

Mr. Hersey. There is a difference in varieties. Some varieties will change a great deal quicker than others. The old Long Red they had to plant thirty years before it was fit to eat, and then there were a few years when it was pretty good. It depends upon the character of the potato how long it will last. The Rose potato holds out remarkably well. I am carrying on an experiment now for the purpose of testing that matter with a new seedling that we call the "Early Plymouth County." It is nearly like the Rose potato.

Question. Did you ever try manuring the potato with salt?

Mr. Hersey. No, sir; I have never tried manuring anything with salt except asparagus, and I found it was worse than nothing. My father experimented a good many years with salt, on the land that I am at work on now, and the reason why I have not experimented is because the result was, every time, an injury to the land.

Mr. Wilcox of Northborough. I experimented with salt and five other kinds of manures, and got the best result from the salt by about one-fifth in weight, and the quality of the potato was the best. I was led to do it by learning that on the Cape, where they had had salt works, the salt works were taken off and they planted potatoes on the land, and got the best potatoes that were ever grown in that region.

Mr. Hersey. Then of course you would infer that there is no need of buying high-priced fertilizers for your farm, but you would buy salt. Every man, of course, must learn what his own farm is adapted to and what fertilizers are necessary to produce his crops, and if he finds salt the best fertilizer, he will use salt.

Mr. Wilcox. I top-dress with other manure on my farm.

Secretary Russell. When our programme reached Houghton Farm at Mountainville, Orange Co., N. Y., where Maj. Henry Alvord is in charge, — whom you all know, formerly residing in this State and deeply interested in our agriculture, — he sent to me by mail this paper which

I am now about to read, that it might come in in due course after Mr. Hersey's lecture. Some of those here present were at the Deerfield Valley Fair at Charlemont, and at the Hampshire, Franklin and Hampden Agricultural Society Fair, where the exhibit referred to in this paper was made.

POTATO EXHIBIT.

[From the Experiment Department of Houghton Farm.]

Shown at the Fairs of the Deerfield Valley Agricultural Society, and the Hampshire, Franklin and Hampden Agricultural Society, in Massachusetts, 1885.

The best method of cutting potatoes for planting has been long disputed and given much attention at farmers' meetings and in the agricultural press. It was decided a year ago to endeavor to contribute something to the public knowledge on this subject, by making comparative plantings at Houghton Farm, and instead of reporting the result in figures, exhibiting the potatoes themselves, just as grown, at the various fairs, with such marks and explanations as would enable every one to judge for himself as to the facts.

Accordingly, at the New York State Fair of 1884, Mr. M. F. Pierson of Seneca Castle, Ontario County, the largest and best informed grower and dealer in seed potatoes in the State, was engaged to make up a collection of a few pounds each, from one hundred to one hundred and fifty varieties, successfully grown by him, to include a number belonging to all the established classes or families of potatoes. Mr. Pierson kept the seed very successfully during the winter and sent the collection to Houghton Farm in the spring of the present year. As received on the first day of May, the potatoes were in excellent condition and represented 130 varieties, divided as follows: — 8 new early varieties; 32 approved early varieties; 24 new late varieties, and 66 approved late varieties.

The place selected for the planting was part of an old garden, cropped for two or three years with onions and cucumbers for seed. The soil was similar to the black soil so well known in the onion-growing districts of Orange County (N. Y.). It was not first-rate potato ground, but was convenient for the purpose and well protected from interference and accidents, which was an important point. The land, after

being put in good mechanical condition, received a moderate and very even dressing of muriate of potash and phosphatic lime, harrowed in.

The land was carefully laid out in squares, a space nine feet square being allowed for every variety. It was decided to plant the varieties in three different ways, as to form of seed, and with three hills in each way, to guard against accident. This gave nine hills of every variety, and the whole field was planted three feet apart both ways. A large stake, marked with the number of the "lot," was set at the middle hill of every square. It would have been difficult to find anywhere a piece of land more uniform in every respect throughout its area and less liable to affect single hills of potatoes from local causes.

The potatoes were planted on the 20th of May (the ground not being suitable earlier), and as I selected and cut all the seed in person, while my principal assistant, Mr. Emery, planted every hill, I am certain that in this part of the work all were treated exactly alike, and there was no possibility of error. The squares of different varieties were so placed, that the hills of like seeding formed rows across the field, and the different kinds were planted in the same order as that in which they were exhibited at the fairs. The earliest varieties were together at the left, and so on to the right, where the latest varieties were planted. Of every variety, three hills were planted with one fair, whole potato, about the size of a hen's egg; three others had in each hill one good-sized piece of a good-sized potato, the piece having three or four eyes on it; and the three remaining hills were planted each with one eye upon a rather small piece cut from a good-sized potato. It is needless to add that, throughout the growing season, the hills of the whole lot were treated exactly alike; no operation was performed, which would affect the produce of one hill, that was not applied to all the hills, the same day. The usual culture of field potatoes was followed, but very little hilling was done.

The season was extremely unfavorable for the crop. During the months of June and July, the rainfall was less than four inches, instead of from ten to twelve inches for the same months in several previous years. At the time, therefore,

when the young plants most needed water to make their growth, they got none, but were, instead, subjected to the most intense, dry heat. It soon became apparent that this would tell disastrously upon the production of the crop, but as all varieties and the different ways of seeding fared alike, it was felt that the experiment might be profitably completed. The early varieties naturally suffered the most, and this was apparent to every one who saw the exhibit. Abundant rains in August were of great benefit to the late varieties, and these were mostly in vigorous growth when it became necessary to dig them for the fairs. All were dug between the 1st and the 12th of September. At this time, one of the early kinds (the Bermuda Pink Blossom, an imported potato) was still green and growing, and of the late (88) kinds, 50 were ripe, while 38 were more or less immature.

The harvesting was carefully supervised by Mr. Emery, one hill at a time, and everything half an inch in diameter was saved. The total product of every hill, when dry and clean (but not washed), was weighed, all the tubers counted, the number merchantable counted, and then the whole put away in a stout paper bag, plainly marked, all the facts being recorded.

For exhibition, a table was prepared, especially suited to the exhibit, one hundred feet in length. On this table the potatoes for exhibition were arranged, in three rows, according to the different methods of cutting and planting the seed. One hundred and twenty-eight (128) varieties were shown, and the whole product of three hills of every variety, that of each hill in a small wooden tray by itself. There were thus 384 trays in all. The back row of 128 were from the whole potato as seed, the middle row from the usual cutting, and the front row from the single eye planted. Every hill or tray was plainly marked with the name of the variety and the method of seed planting. Examined from left to right, every row showed the effects of the same way of cutting upon different varieties. From back to front, in sets of three, the effects were shown of planting the seed of the same variety in different ways. As a whole, the potatoes were inferior in quality, although in several cases single hills produced from three to five pounds. But that was immaterial, — the

exhibit was not intended as a *show*, but as *an object lesson*. giving at a glance the results of the three ways of planting, Large cards accompanying the exhibit gave the average results in figures. These may be condensed as follows: —

The Average of 128 Varieties of Potatoes.

METHOD OF SEED CUTTING.	Whole number of Potatoes per hill.	Number of merchantable potatoes per hill.	Average weight per hill, ounces.	Average weight of tubers, ounces.	Computed product per acre, bushels.	Land required for 100 bushels, sq. rods.
Whole potato (back row), .	20	9¼	48¾	2.4	316	51
Usual cutting (middle row),	13	6½	33¼	2.5	215½	74½
Single eye (front row), .	10	5½	28¼	2.8	185½	86¼

One set of these figures may be deceptive; although it appears that the average weight of the potatoes in the front row (single-eye planting) was the greatest, the number of large potatoes was greater in the back row, and the largest potatoes were there also. Therefore, in every way of viewing it, so far as this one trial is concerned, the planting of fair-sized whole potatoes was the most satisfactory in result. And this was not the result with only a single kind, but the average of 128 different kinds, treated exactly alike in every respect except the form or cutting of the seed.

The tabular record in detail forms a mass of figures quite confusing unless studied very closely. But with patience a good many interesting facts may be obtained.

First, to show the effects of the season better than the brief statement already given, this arrangement has been made: —

	Product of 3 hills whole potatoes.	Product of 3 hills usual cutting.	Product of 3 hills single eye.	Product of 9 hills.
40 early varieties, . .	116½ oz.	78¾ oz	67¾ oz.	263 oz.
64 late varieties, . .	132¾ oz.	89⅖ oz.	73⅙ oz.	295¼ oz.

As far as comparison of varieties is concerned, the following

facts appear, but it is unfair to judge of the merits of any kind from observations in a single season.

a. In productiveness alone, the seven varieties leading stand in this order: — American Giant, Burroughs' Garfield, Cheeseman's Seedling, Riker's Graft, Chief, Beauty of Hebron, O. K. Mammoth Prolific.

b. In greatest number of merchantable potatoes, this seems to be the order of preference: — Farina, Blush No. 2, Chicago Market, Defiance, Beauty of Hebron, Rural Blush, Burroughs' Garfield, Adirondack.

c. Of the varieties in the two lists just given, the following are objectionable because rough and of bad shape: — Chicago Market, Burroughs' Garfield, Adirondack, American Giant (rather deep eyes), Cheeseman's Seedling, Defiance.

d. And this leaves as favorably recorded on account of gross productiveness and merchantable in regard to both quantity and condition, the Beauty of Hebron only.

HENRY E. ALVORD,

Manager.

The CHAIRMAN. Now, gentlemen, the subject of potato culture is open for discussion. Are there any further questions to be asked Mr. Hersey? If so, I presume he will be ready to answer them, or we will be happy to hear from any one present on the subject.

Mr. HUNT of Milford. I planted some Early Rose that were very badly affected with the scab. I planted another kind of white potato (I don't remember the name) that was very free from scab. They were planted in the same row, side by side, and the crop from the Rose was very scabby, while the other potatoes were as perfect as I ever saw. They were large and they produced more than as many again as the Early Rose. I wish to know what the cause was, if there is any one here who can give the information. I planted them with barnyard manure, which was spread upon the ground, without any fertilizer or any manure in the hill. It would seem as if there must be some cause for it. If the scab is a disease, I do not see why it does not

affect one kind as well as another; and if it is some insect, it would seem to me that that ought to affect one kind as well as another. It could not be owing to the manure, because there was no manure in the hill. So the cause is to me a mystery.

Mr. Hersey. I have already said that I am in the dark in regard to the scab. It comes when it pleases and goes when it pleases. I planted some potatoes three years ago, under circumstances where I should have supposed that there would not have been a scabby potato, and yet they were most of them scabby. I planted potatoes this year in a place where I should have supposed they would certainly have been scabby, and yet they were entirely free from the scab. From the trial of different fertilizers I have thus far been unable to make any progress at all. I do not know why one kind of potatoes that the gentleman planted was scabby and the other not, unless it may be that one variety was more susceptible to the disease than the other, or was more liable to be attacked by an insect, if it be an insect. If scab be a disease, then we might conclude that the variety which was diseased with the scab was more susceptible; it has not a constitution strong enough to throw it off. I think that the potato is quite different from almost anything else which we plant. I have no doubt that it takes up disease very readily. Then, I suppose you will ask, "Why was it not scabby the year before?" That is a question which I cannot answer.

Mr. Ware. This subject of the scab is a very important one, and, as Mr. Hersey has said, perhaps there is very little known about it; but as the result of some observations that were made a year ago, I am satisfied in my own mind that it is not the work of an insect, but is the effect of a fungus. While watching for this disease, I found that when the potatoes were growing rapidly, they were marked with little white specks, and I watched those white specks grow from day to day, and finally they had the appearance of a blister, which burst open, and as the potato grew, the break, which was small at first, enlarged, and as it matured, the break healed over and became a dry surface, or scab, such as we have observed. I am satisfied in my own mind

that it is the result of a fungus growth rather than of an insect. But you will ask, "What is the cause of this fungus growth? Why are some potatoes affected and others not?" The same answer may be given to that as in the case of the potato rot, which, as is pretty well established, is caused by a fungus growth. It comes only in a certain stage of the growth of the potato and under peculiar conditions of the atmosphere. This fungus that produces the scab comes, as I claim, only in a certain condition of the growth of the potato. Now, I cannot say whether or not this comes from a peculiar condition of the atmosphere; I doubt it; but there are the spores or germs of this fungus growth, and I claim that wherever they can find suitable conditions of soil, they grow and mature, and when they burst open they throw out their spores, ready for future germination.

This is a very imperfect explanation, but it is satisfactory to my mind that it is not the result of insects, but rather that it is an attack of the fungus. I do not propose to suggest any remedy, because if any one should say that under certain kinds of fertilization the scab has come and under certain other kinds it has not come, some other person will be prepared to say that in his experience the reverse has been the fact, so that I do not think that we can claim that it comes more generally with manure or with fertilizers. We do not know whether it is more apt to come in new soil or old soil. The conditions under which these spores fix themselves I think are not well known, but with this hint and with this suggestion, as the result of careful observation, watching from day to day the development of this form of disease, something may grow out of it.

I thought, as there had been so much inquiry with regard to this matter, that I would give the result of my observations, which to me was quite satisfactory, but not a sufficient explanation of the cause.

Mr. GODDARD of Barre. I agree entirely with my friend Mr. Ware upon one point, that scab is the result of a fungus, and I believe, from what observations I have been able to make, which have been somewhat limited, to be sure, that this fungus may be traceable to climatic influences; that is,

to the atmosphere. I have found that a certain variety of potatoes, which I have raised for several years with very satisfactory results, has been almost entirely free from scab, and yet this year the same kind, raised in the same way, as far as I could determine, have been affected by the scab. I I could not attribute it to the mode of culture or to the manuring, and so I fall back upon what I have mentioned.

One other point which has come up here is with regard to the planting of small seed. I have made some limited experiments in that line; not so elaborate as those of my friend Mr. Hersey, but I have gone sufficiently far to satisfy myself that it is best for me to plant medium-size, solid potatoes, — not the smallest nor the largest. I have tried large and small seed side by side, some of the small potatoes being no larger than the end of your finger, — cutting up the largest potatoes, of course, — and the result from the same number of hills was more potatoes in weight from the small seed, and of very much more uniform size.

With regard to planting in hills or rows, for general culture and to obtain the best results as a crop, I believe it is best to plant them in rows, say three feet and a half apart, or what we call in drills, placing one medium-size potato, without cutting, once in about eighteen or twenty inches, and we may find it desirable to hill them up somewhat. Of course, that, as Mr. Hersey suggests, depends very much upon the nature of the soil. My soil is loam, with a clay subsoil.

Capt. Moore of Concord. There has been but little said about the cultivation of the potato and the best ways of cultivating it. I do not claim to know the best way, but still I have grown large crops of potatoes. Before I speak of the method of cultivation, I would like to say a word about this matter of seed. There is no such thing as "seed," in our method of raising potatoes. It is simply a tuber. We call it "seed" sometimes, but it is not seed in any sense. Instead of speaking of what is planted as "small seed" or "large seed," it would be better to call it "large tubers" or "small tubers."

Now, in regard to cultivation, the first thing that I think a Massachusetts farmer has to look after is the fact that we are having constant droughts, and we have got to fight them.

The only way to grow potatoes and avoid the effects of a drought is to plant them deep enough, without hilling up. Of course I understand that there are some lands so wet that you must hill them up, but that is not the usual land that potatoes are grown on. If I wanted to raise the largest crop that I thought I could grow, and wanted to raise it on a piece of grass land, I should do it in just this way, — and I have raised very large crops by this method. I should take that piece of ground about the middle of May,— as late as that, anyway, — and put on a heavy dressing of raw stable manure on top of the grass, and I should like to have the grass up six inches when I put it on. Then I would plough that piece of land five inches deep. You will ask me the reason why I would not plough it any deeper than that. The reason is, that if you turn that manure down seven or eight inches deep, you get it down where it is so cold that it does not act for a long time, and you may lose the benefit of some of it; whereas, if you only put it down five or six inches, then the manure is near enough to the surface of the ground so that it gets the benefit of the heat, the air and the rain, and decomposition is caused to go on there, and you have formed a seed bed that will grow potatoes better than any other way you can grow them on sod ground. Then furrow that ground just as deep as you can without turning up the sod. I am talking of good, smooth, level ground; I am supposing that it has been ploughed well. After you have done that, plant in drills, having the pieces about ten inches apart in the row, and if the ground is well manured, and in the condition of my land, the tops, with the rows three and a half feet apart, with a potato like the Beauty of Hebron (which is the best potato of all the varieties grown now; I have no doubt about that), the tops will cover the ground so that you will have to work your way through them to get through the rows, with simply one piece in a hill.

I cut up the tubers, and I cut them because I never have been able, after trying a number of times, to see any particular difference in the quantity of potatoes that I have got, and I have always been satisfied that I got a more uniform size of potatoes where there was not too much seed in a hill.

VOICES. Tubers! [Laughter.]

Capt. MOORE. You have talked about "seed" so much that I have almost come to think it is seed. Now, in planting on sod land, those potatoes must be covered with the hoe; you cannot cover them well otherwise. If it is old ground and perfectly smooth, I should furrow that out perhaps seven inches deep, drop my potato in the bottom and cover it with a horse plough, turning one furrow over it, which would leave it looking very much as if you had been running a plough there without any particular object. Then in eight days, perhaps, after I had planted it, I would take a leveller, — which is five pieces of plank nailed together, — and go over that piece crosswise and level it just as smooth as this floor; and then, in four or five days after that, you will see your potatoes coming up in straight lines, if you have furrowed your rows straight, and you can run a cultivator so near to the potatoes that there will be no occasion to use the hoe. Even if you throw a little dirt on them it will do no harm. All my potatoes on old ground have been grown in that way for the last four or five years, and there have been no weeds in the piece and no trouble in keeping them down. The last thing I do before the tops get ready to fall, is to take a horse plough and throw a little dirt up to the rows. The result has been very large crops of potatoes, and for the last two years I have been obliged to "deacon" my potatoes when I sent them to Boston. That is, I have not put the largest ones on top, because they were not the best looking.

You will not have the scab where you have high culture, because you put the plant into such a condition of strength and vigor that it resists the attacks of the fungus.

I do not regard the potato bug as doing quite as much damage as many farmers suppose. I know they will eat up and destroy a field of potatoes if you will let them, but there are other insects, which prey upon potatoes and which riddle the leaves full of little holes, which are destroyed by this same application of Paris green which kills the other bug, so that you get better crops than you used to do before the potato bug was known.

Mr. WARE. Our friend Moore is critical, and I would like to criticise him a little. He says that on sod ground,

with the grass six inches high, he would spread a good coating of manure and furrow it deep, as deep as he could without turning up the sod. I would suggest a better way, and one that will avoid the necessity of covering with the hoe. Every third furrow that you plough, drop your potatoes, — I assume that you plough with a side-hill plough, so that you will not go round, — and the next furrow that you turn will be thrown right over the potatoes you have planted, and they will be covered five inches deep instead of three. In that way you will save considerable hand labor and get them down where you want them, where the manure is and where the grass is all decomposing.

Capt. MOORE. The objection to that is, that I use two horses in ploughing, and if the potatoes are planted in the way the gentleman suggests, the horses will trample them all to pieces.

Mr. WARE. The way to avoid that is to drop the potatoes close to the furrow that is turned over.

Capt. MOORE. Men who are farmers here will see that in an operation of that sort they could not keep their dropping along with their ploughing; and if they do not plough any better than they do down in Essex County, the rows will be so crooked as to make your head swim. I have tried that method, but it is very difficult to get the rows as straight as I want them, and the straightness of the rows saves a great deal in the after cultivation. That is one reason why I do not follow that method; and one reason why I recommend ploughing so shallow is, that I find that is the most practical method of composting manure that was ever invented. You have got your manure, your sod and everything decomposing, and you have put it where it will be in the condition in which you want it at the time the plant needs it; and with that fresh manure, and with the sod, you have substantially done what the market gardeners do; you have furnished a hot-bed to those plants, and the crop comes along in a hurry. I should not dare to tell you how large crops I have grown, because I am afraid you would not believe me.

Mr. HUNT. The gentleman, if I understand him, says that high culture prevent the scab. I would like to have

him tell me how it was in my case, when I put a large quantity of manure on the Early Rose, and the potatoes were so diseased that my wife would not use some of them, and the other kind were perfect potatoes? They were planted in the same way, on the same ground, the culture was the same, the same amount of manure was put on the Early Rose that was put on the other kind, and yet there was this great difference in the crops. It appears to me that high cultivation does not dispose of the scab. A gentleman,—Mr. Hill,—who owns some land right by the side of me, has had the same experience. Last year he planted the Beauty of Hebron, and there was no scab whatever on his potatoes; this year they were so badly affected that he could market only a part of them, and had to sell those he did send to market at a reduced price, because they were so diseased. That could not have been owing to the cultivation, because he cultivated them last year the same as this.

Capt. Moore. I am not speaking of any particular case; I wanted simply to emphasize this idea, that any plant that is grown resists disease better under high culture. I do not think that can be disputed.

Mr. Williams. I would like to ask the gentleman from Milford if the tubers that he used in planting the Early Rose were perfectly free from the scab?

Mr. Hunt. I selected those that were, as near as I could. In planting potatoes I do as my friend Hersey does in his experiments,—I get the soundest and best for seed that I can find. I calculate to get perfect potatoes. I do not say that there was not one that was imperfect, but, as a general thing, they were perfect potatoes.

Mr. ———. I understood Mr. Hersey to say that in planting the tubers he broke the sprouts off so that there should not be too much seed. I would like to ask if there would be too much seed; whether there is any need of breaking the sprouts off before planting, or whether he would break them off when they came up?

Mr. Hersey. The object in trying the experiment was to ascertain the strength of different sized potatoes, and it would not have been fair to allow a large number of sprouts to come from the small ones and only two from the large

ones. That was why the sprouts were taken off. The result of planting all the eyes, in my experience, is a larger quantity of potatoes, — larger than if you take off all but two eyes; but the seed potatoes — *tubers*, I suppose I must say — will not be as uniform in size.

Question. Would you let all the sprouts grow from the the whole potato?

Mr. Hersey. If I was going to plant whole potatoes, I should feel under the necessity of allowing all the sprouts to grow, if I had a large field, because I think the labor of cutting the eyes out or of cutting off the stalks would be too much; but yet I am of the opinion, from my experience, that we get better results from planting medium-size whole potatoes than we do from cut potatoes; and I think the reason of it is because of the fact that, in cutting potatoes, we lay the inside of the potato open to the air and it is more susceptible to changes. We often find a great difference in the result of different days' planting of potatoes, when they are good ones, and I apprehend that this difference is caused, mainly, if not entirely, on account of the difference in the temperature, the difference in the weather; that one day you may plant a good potato and the weather does not affect it nearly as much as it does another day. Now, if you plant a whole potato, being protected by its skin, it is not susceptible to those changes of weather, and the result is more uniform and I think always better. I think your young plant starts off better by having the whole strength of the potato to start with than it does if you only plant half of a potato, or a part of it, leaving it exposed to the air.

Now in regard to planting potatoes with the sprouts on. That experiment was tried for the purpose of ascertaining whether taking off the first sprouts which came from the potato weakened what was left, and the result was perhaps what most of us would expect, — that taking off the first sprout that comes up, and obliging the potato to force forward another sprout to take its place, weakens the vitality of the potato, and the result is a greatly reduced crop. Therefore we learn from this fact that if we are to plant the best tubers we must select those that have not sprouted very much, so that the sprouts will rub off. I think that

we do not pay attention enough to keeping our *seed* (as I shall persist in calling it) as it ought to be. I believe, if we wish to do the best that we can in growing potatoes, we shall always select our seed potatoes when we harvest the crop, and keep them where they will not sprout very much until we get ready to plant them. I believe that is a matter which all potato growers should consider. In my opinion, they would get, as a rule, at least one-quarter more potatoes from seed that is well kept than they would from the potatoes that we usually plant; that have been kept where they have started, or where they have got soft, or where they have been dried, or where they have been nearly frozen. It is always a risky thing to buy potatoes, on account of the fact that we do not know how they have been kept, and if I were to recommend anything to the farmers of Massachusetts in regard to planting potatoes, I should recommend them to be very careful in the selection of the seed; to select it in the autumn, and keep it where it will be kept perfectly sound and in good order.

Mr. Ware. The question which the gentleman in the rear of the hall asks with regard to sprouts coming from the whole potatoes indicates a misapprehension on the part of many as to the effect of planting whole potatoes. In that case, the fittest survive. If you plant a whole potato, every sprout will not grow and make a stalk; there will be but two or three, and they will invariably come from the seed end, so called; so that if there are twenty eyes on a potato, there will be, I think it is safe to say, but two or three that will send up sprouts that will grow.

Mr. Hartshorn of Worcester. I have been very much interested in Mr. Hersey's remarks to-day, and many of my theories about potatoes have been vindicated by his experiments; as, for instance, in regard to planting small potatoes, and in regard to the stem end and seed end. In regard to the scab, I think, if farmers want to avoid that as far as they can, if they will plant the Beauty of Hebron and harvest it as soon as it is ripe, and not leave it in the ground, they will help themselves materially. I do not think there is anything gained by keeping them in the ground. They should be either marketed at once or put in the cellar.

In regard to the selection of seed for planting, I am reminded of a circumstance that happened in my experience, four or five years ago. I went to Boston and bought four barrels of the best potatoes I could find, from the Provinces, as I supposed. I thought I would try an experiment. When they came to my place, I found that three of the barrels came from the Provinces. The other barrel came from somewhere else; I suppose from the vicinity of Boston. The potatoes that came from the Provinces yielded a very handsome crop, while the crop raised from the other barrel was much smaller and the potatoes were of an inferior quality. An adjoining field was planted with potatoes of my own raising,—the Early Rose,—and those did not begin to yield as well as the potatoes that came from the Provinces. If we can get a much better crop from Nova Scotia seed than we can from any other, as Mr. Hersey says, is it not better to get our seed from there instead of planting potatoes that we have raised ourselves?

Adjourned to two o'clock.

Afternoon Session.

The Chairman. The lecture this afternoon will be by Mr. James J. H. Gregory of Marblehead, whom I have now the pleasure of introducing to you.

ERRORS IN ESTIMATING THE VALUE OF MANURES.

BY JAMES J. H. GREGORY OF MARBLEHEAD.

The best practice applies manure where the different crops will readily find it; it does not send the roots of heat-loving plants (such as corn, squashes, cucumbers and melons), down into the cold earth to get their food. There is less and less manuring of the soil and ploughing under for corn, and I hope the practice of quarrying down among the rocks and hard clay of the subsoil to make manure cellars in which to plant our squashes, melons and cucumbers, will soon be discontinued. This class of plants revels in a hot soil, and one so light as to be easily penetrated by their fine, silk-like roots. Our fathers struck deep with the ploughshare, and buried

the manure, like some monster of old, where all struggles to escape were unavailing; they then planted their various crops above the helpless wretch, to devour his vitals. They believed (and some of their sons are chips of the old block): 1st, that all plants were to be fed with the same food and in the same way; and 2d, that barn manure was volatile, and hence would waste if spread on the surface where it would be exposed to the sun and air. The three essentials of all barn manure are, as we know, potash, phosphoric acid and nitrogen. The first two (potash and phosphoric acid) are not volatile, I think I may say, at any stage of their existence; therefore they cannot evaporate. The nitrogen in stable manure is volatile, to a small degree, in some stages of fermentation; but as usually applied to the land it is in a latent condition, and like the potash and phosphoric acid cannot evaporate. It is a well-ascertained fact that, when decomposition is taking place, the soil greedily seizes every particle of ammonia in contact with it, the instant it becomes free, so the tendency of stable manure to waste by evaporation when applied to the soil is very slight. Rain renders the component parts more or less soluble, but the particles are at once absorbed by the hungry soil. Even when applied to the surface of a hillside, where the wash formed a pond of dark-colored water at its base, it was found that the land where the water stood produced no better crops than the hillside. The great argument in favor of manure being as near the surface of the soil as possible (spread on the surface and harrowed in, for plants requiring considerable heat), is that it may have the advantage of sun and rain to convert its component parts into plant food by making them soluble. The only practical objection to manuring on the surface, is the stimulus it gives to weeds. But the old saying holds good, "no weeds no crop," for pace and pace with the weeds grow the crops; and if I find that the weeds on my land grow more lusty than on the land of some of my neighbors, who plough all their manure under, in the same ratio grow my crops.

The Undervaluation or Overvaluation.

We farmers of the Atlantic slope measure our prosperity by the size of our manure piles. On the contrary, the farmers

dwelling on much of the prairie region of the West, and along the river bottoms, look upon manure as a nuisance to be got rid of; and he who has a stream near by into which he can dump it is thought fortunate, while others throw it out of the barn until it accumulates in such quantities that it finally becomes a question whether the manure shall be removed to enable them to get to the barn, or the barn itself shall be taken down and removed elsewhere to get rid of the manure barricade. Not unfrequently the last plan is adopted. I remember the impression of waste that I received, several years ago, while travelling along the Mississippi River I saw near a town a dump where the manure of the town was shot down the bank into the hurrying river below. Probably there is not an editor of any agricultural paper published in the East who has not received letters from subscribers in the West, protesting against so much space being devoted to articles treating on manures and their application. Our brother farmers in the West are probably as wise for their day and generation as are we in ours. We don't invest time and money in manure because some theorists tell us that otherwise our land may in time become impoverished; we don't put our ears to the ground to catch the sound of the marching of coming generations, — the farthest that civilization has advanced is to plan a four years' rotation. We manure our farms because we make money by doing so. Our western brothers do not apply manure, because the increase in crop thereby, on their rich, virgin land (with corn, it may be, from ten to twenty cents per bushel and wheat considerably under a dollar), would not pay for the cost of the labor of handling it. On those river bottoms, subject to an annual overflow, barnyard manure would prove a positive injury to the grain crop, stimulating a rapid growth of weak stalks which would not sustain the weight of the ripe grain. On such soils, instead of manure, the great want is access to some of the barren sand-heaps that make the sterile spots on our New England farms. I consider this whole manure question self-regulating; in other words, that the intelligence and enterprise of the average American farmer will lead him to use manure wherever and whenever he believes it will pay him to do so.

Some Errors drawn from the Study of Valuation Tables.

The tables giving the valuations of manures made by feeding a ton each of various vegetables and vegetable substances, by such men as Dr. Lawes, are very useful if rightly used, but I incline to the belief that they are made to prove too great a difference in the value of the manure made. These tables tell us, for example, that while the manure made fróm feeding a ton of carrots is worth but 80 cents, that from feeding a ton of cotton-seed cake is worth $27.83 ; in other words, they are to each other in the ratio of 1 to 33. The inference is that it is better to feed fewer carrots and more cotton seed. But when we take into consideration the fact that, while a ton of cotton-seed cake costs in the market $28, a ton of carrots can be bought for $7, we find that when compared, value for value, the ratio shrinks from 1 : 33 to 4 : 33. Following out this line of investigation, and assuming that in the one instance two quarts of cotton-seed cake per day are fed, in the other a bushel and a half of carrots, we find, by figuring, that during the six months of barn feeding, say from October to April, there would have been fed 273 bushels of carrots and 364 quarts of cotton seed ; or assuming that they are the Danvers class, weighing about 35 bushels to the ton, $7\frac{8}{14}$ tons of carrots and $11\frac{3}{8}$ bushels cotton-seed cake, or 455 pounds. Now the value of these manures by the tables shows 80 cents per ton for the carrots and $27.83 for a ton of cotton-seed cake. That would be, for the carrots, $6.12, and for the cotton seed, $6.14. Therefore the man who uses the manure of a cow that has had fed to her $1\frac{1}{2}$ bushels of carrots daily, gets just about the same value in plant food as though he used the manure of a cow that had the same feed of hay and grain, but had two quarts of cotton seed daily instead of the bushel and a half of carrots. As to the wisdom of feeding the carrots instead of the cotton seed, I will only remark in passsing, that to the isolated farmer market prices for vegetables are at times merely nominal; he has to feed the roots he raises, and with the crops of carrots this year reaching as high as 48 tons to the acre he can afford to feed pretty liberally. He who would keep his farm in the best condition will be greatly helped by such tables, if they are wisely

used. We read a great deal about the value of silo food for milk, but very little of the quality of the manure made from it. The same may be said of the feeding of roots; yet in the long run the prosperity of the farm depends as much on the manure, as it does on the milk-producing qualities of what is fed. The well-balanced ration calls for food rich in phosphoric acid and nitrogen, when silo food or roots are largely used. The ration system is therefore in harmony with the best interests of the farmer, for by following it he not only takes the best care of his animals as a milk or beef producer, but at the same time enriches his manure pile also. As an illustration of the change that may be made in the quality of the manure by the food eaten, it may be stated that by feeding two quarts of cotton seed daily to a cow in milk, the manure from such a cow, solid and liquid, would in its richness be equal to the best horse manure.

The Underestimating of Fertilizers when comparing them with Barnyard Manure.

How can fertilizers be so essentially different from barnyard manure as many farmers believe them to be? The value of each of these as plant food is measured by science; viz., by the quantity of potash, phosphoric acid and nitrogen contained in each. The difference is, that fertilizers lack the water and vegetable fibre which give bulk to barn manure and ultimately increases the humus or black earth of the soil, a substance which of itself is not plant food; but, on the other hand, the plant food of fertilizers is as a rule prepared for ready assimilation by plants. All the phosphoric acid, potash and nitrogen that is in the manure must have been in the rations fed to the cow; but by analysis we find that there was more in the food than there is in the manure. Now where has the difference gone? To make up the bones, flesh, hoof, hair, horns, etc., of the cow, and if we pass the dead cow over to the chemist, he will find the difference. That is, all the phosphoric acid, potash and nitrogen fed to the animal can be found in the manure plus the cow. Now a fertilizer is made out of the waste portions of the cow. But in the manure itself we have a source from which our fertilizers could be manufactured were it not a more expensive process. It

is simply because there is more waste to be got rid of that manufacturers do not drop the cow and take up her manure as the material from which to make their fertilizers. Every farmer knows from experience that the remains of a dead animal buried around his trees makes them grow, but he sometimes lacks faith when the chemist presents a few pounds of the three fertilizing elements and tells him that is all the plant food to be found in the remains of the animal. After drying away the 70 per cent. of water, I challenge anybody by the sharpest scrutiny, even when aided by the microscope, to detect anything in what remains, except a mass of fibre in a greater or less degree of fineness, all more or less slightly discolored. The phosphoric acid, potash and nitrogen which we believe is there, the chemist must find for us, for we should be just as helpless in our search for them as when examining a commercial fertilizer.

Soil sometimes Overvalued as Plant Food.

We farmers are apt to overvalue for plant food the soil we cart into our pigstys. As an absorbent for the urine, or to reduce the strength of the excrements to a desirable degree, it is useful; but it does not add to the plant food in the manure. The action of the snout or feet of a hog cannot increase plant food, as far as soil is concerned. Where green vegetable material is used, by causing it to rot in the soil the plant food in it may be made more available, but it is not increased; and in cases where such vegetable waste is on tillage land, I submit that the plant food in it would be as available by letting it remain and rot where it is, as by carrying it to the hogpen. The value of the plant food the hog can make is to be measured by the potash, nitrogen and phosphoric acid that enters him in his food minus the quantity taken up in his growth. The hog may make a mixture of various substances thrown into the sty, but he has no creative power to add to the plant food already there. Under certain circumstances, the latent ammonia in muck may be made available by throwing it into the hogsty, but even for this I believe that active fermentation is necessary. Here let me draw the line of distinction between a mixture and a compost. A compost heap is one where there has been a de-

struction, by fermentation and decay, of the organic structure of every vegetable and animal substance that entered into it; a development of the plant-food capacity in each to the greatest possible extent, and its homogeneous distribution through the entire mass. What farmers usually call composts are really but little more than mixtures. To produce a compost is the work of nature, requiring many months of warm weather. We aid her by frequently turning over the heap to help intermix the materials and admit the air (oxygen) necessary to maintain chemical action. When we let our materials remain together sufficiently long to develop heat, we call the result a compost. It is far from it. Farmers are apt to consider any combination of odd vegetable material manure, and the greater the variety the greater the manure value. Now, I hold that, practically, muck represents the ultimate results of vegetable decay, and, therefore, may be considered the equivalent in value of all decayed vegetable matter. It is far cheaper to use this, where it is accessible, than to spend time, labor and team in carting tan, or like substances, to our farms, which usually cost more to cart on account of bulk, while they are not after all in so available a condition.

Unleached Wood Ashes Undervalued.

Unleached wood ashes are at times undervalued by farmers. We often hear of instances where leached ashes produced just as heavy a crop as unleached, used side by side at half the cost. Such results are often used as an argument to prove that leached ashes are worth as much to the farmer as unleached. Unleached ashes, with the exception of nitrogen, is a complete fertilizer in itself, having all the elements of average plant growth in proper proportions. The most valuable element is the 7 or 8 per cent. of potash. In leaching, nearly all of this is taken out; how then can leached ashes be worth as much for plant food as unleached, though it is certainly true that in numerous instances one has grown just as good a crop as the other? Obviously such apparent contradictions are explained by the fact that potash was not what the soil needed; it was either phosphoric acid or lime, the former of which is found in about the same quantity in

each, while of the latter there is a larger proportion in the leached than in the unleached. In such cases it may be considered doubtful whether the land needs an application of ashes It would be better first to apply lime and phosphoric acid separately and in combination, as an experiment, before deciding to buy for the future unleached ashes; for if it be found that either one or both of these answer the same purpose as the unleached ashes, it might be cheaper to purchase them in other forms, — for instance, the lime as carbonate of lime (common stone lime), and the phosphoric acid in superphosphate of lime.

Stones as Plant Food.

The value of stones in the soil to increase its fertility is doubtless overestimated. I have been told that an enterprising farmer, after having cleared his onion bed of all stones large enough to interfere with the working of his weeding hoes, noted that the crop decreased, though manure was used as abundantly as before. Assuming the cause to be the removing of the stones, he brought them back again, when, in his opinion, the soil recovered its former fertility. Was there in this instance any relation between cause and effect?

The stones found scattered over the surface of New England were deposited, geologists tell us, during the glacier and drift periods of the earth's history, hundreds of thousands of years ago. In many sections they evidently have suffered but little or no decomposition during this vast interval of time. To what measurable degree, then, can man expect to obtain plant food from them during the few years that fill out a human life?

The trap, sienite, and porphyry rocks may be assumed to be practically indestructible; the little matter obtained from them being at the cost of hoes, blades, harrow teeth and plough points, making it an exceedingly dear plant food.

Some granite rocks I have seen surrounded with a bed of light-colored decomposed material, evidently formerly a part of themselves, a deposit rich in potash from the feldspar in their structure.

This looked suggestive of the value of rocks for plant

food, until I called to mind the fact that it had taken about a couple of hundred thousand years to make it!

Rocks may be of service to lighten some soils; to draw heat or condense moisture. The chemicals in the soil may act very slowly on them, and friction with farming tools wear a very small fraction of their number very slightly; but all the plant food supplied to the crop by such stones as stand in the way of good farming, could, I believe, be far more economically and fully as abundantly applied to the land by an annual dressing of a handful of potash to the acre.

Proper Valuation of Manures.

Near great centres of population a singular kind of farming thrives, where men may be said to make a living at farming, yet make nothing at farming.

I stood by, one day, and saw a thrifty farmer apply 20 cords of rich compost to an acre of land. He planted the piece to Hubbard squashes and raised a crop of about 9 tons. These he marketed in Boston, 16 miles distant, at $20 per ton, getting $180 for his crop. That manure — a combination of muck, night soil and rotten kelp — was worth on the ground where it was used, taking the price of stable manure in the same locality as a basis, $8 per cord, the cost of the crop was about as follows: —

Manure,	$160 00
Rent of land,	15 00
Growing and gathering crop,	25 00
Marketing the crop,	18 00
	$218 00
Deducting price received for the crop,	180 00
Loss,	$38 00

Such farmers succeed, not because of their nearness to a city market, but because they buy their manure (mostly night soil) for a very low figure, — the mere cost of collecting it, — and they sell it in their crops at about the market rates for stable manure. *Their profits are on their manures, not on their crops;* they often sell them below the cost of production.

Many of them who succeed can hardly be termed what they claim to be, successful farmers. It is, in brief, *a case of undervaluation of manure.* A farmer from the interior of the State, visiting them, would naturally attribute their apparent prosperity to good crops and a good market; but give to him manure as good, as cheap and as abundant, and on his cheaper land he could probably compete successfully with his suburban brothers, even though he had to freight his crops by railroad and pay 10 per cent. to the commission merchant who sold them.

Plaster, Salt and Lime not Manures.

The application of a few bushels of plaster, salt or lime will produce a wonderful increase in the crops grown on some soils, and these we are apt to consider plant food, but they are not. A moment's consideration will make this clear. Plaster or gypsum, or, using another name for it, sulphate of lime, is a combination of sulphuric acid and lime. Salt is a combination of chlorine with soda, and carbonate of lime a combination of carbonic acid with lime. Most soils to which they are applied contain sufficient of each of these substances, in an available condition as plant food, for all crops. Chlorine enters into the combination of but few crops to any noticeable extent; and nearly the same may be said of soda, which plants have the power to replace with potash, should the supply for any crop be wanting in the soil. As neither of these contain the three essentials in the food of all crops,— nitrogen, phosphoric acid or potash,—hence neither of them are in themselves manures. The true use of plaster and carbonate of lime is to seize upon, make digestible or set free, plant food that already exists. The great agricultural paradox, how two or three bushels of gypsum, which in itself is not to any extent plant food, can cover an acre with a thrifty crop of clover, is solved when we consider how readily the sulphuric acid that enters into its composition separates from the lime with which it is combined, to unite with potash and ammonia, seizing each as they exist in the soil, and the latter (ammonia) as it is formed in the air or in the act of escaping to it. It acts, therefore, as a purveyor of plant food that already exists in the soil and air,

much of it in a dormant condition, which it stirs up and sets in motion.

Hen Manure Overvalued.

"Fifty hens will produce enough domestic guano to manure five or six acres of corn. Hen manure is one of the most powerful fertilizers known," says a contributor to one of our agricultural papers, and in these statements he but reflects a belief very general among farmers. I propose to look into this question of the value of hen manure a little closely, and with a combination of facts and common-sense we will endeavor to determine the actual value of hen manure as plant food.

Unless chemistry is wrong in its teachings we generally overestimate the value of the droppings of the poultry house as a fertilizer. One source of this error has arisen from the fact that the ammonia in hen manure is in a more available form than in barn manure, and therefore crops to which it is applied start off with greater vigor. Average hen manure, taken fresh from the coop, chemists tell us, contains the same amount of potash and phosphoric acid as average barnyard manure, and $1\frac{3}{5}$ as much nitrogen. This would make hen manure (assuming it to weigh when fresh about the same as stable manure, which by actual test I found to be a fact — 48 lbs. to the bushel), worth about $11\frac{3}{5}$ cents per bushel, gathered fresh, when stable manure is worth $6.50 per cord. It is oftentimes compared in value with Peruvian guano. I suppose the fact that it is the excrement of birds suggested the comparison, but there it ends; for when we come to consider the elements that enter into the food of our domestic fowls and of sea birds, and the great concentration of richness that ages of rotting has produced in the manure of the latter, all ground on which a comparison can rest is taken away. Now, fowls of average size, kept in coops and having free access to food, will eat the equivalent of about two bushels of corn a year; the larger breeds, I find, by a test I made 30 years ago, will eat from a third to a half more. From this food they must make material for about 125 eggs annually, grow a change of feathers and sustain the growth of the body, besides performing the various functions upon which life depends.

Subtracting from the two bushels of corn what is required for all this, the waste elements remaining will shrink to *very small proportions.* In this connection we must also take into account the fact that the droppings we save are usually those made during one-half of the twenty-four hours,—those found under the roosts. From this standpoint it will be seen that the droppings of a hen for a year cannot contain nearly the value claimed for them.

Let us endeavor to determine its value from another standpoint. In estimating the value of the manure from any animal we must remember to be governed by the general principle, that *no more nitrogen, potash and phosphoric acid can be found in the manure than is found in the food eaten.* By chemical analysis 2 bushels of corn are found to contain 38 cents in value of nitrogen, potash and phosphoric acid. If we feed our poultry much of animal food it will, of course, add to the value of the manure, while in all calculations of value some allowance must be made for the insect and vegetable food that even the best fed poultry will gather for itself. For reasons already given, it is reasonable to infer that the manure saved could not contain over half the fertilizing elements fed; and, besides the sources of loss named above, a large proportion of the nitrogen, from the animal food especially, must find its way into the composition of the eggs. The analysis of the contents of the egg is: Potash, 0.16; phos. acid, 0.39; nitrogen, 2.00. At nine eggs to the pound this would give about 5 cents as the value of the nitrogen in the eggs laid by the average hen per year. By an analysis of the grain fed we come to almost the same conclusion reached by an analysis of the manure itself; namely, that the manure saved under the roost from the grain fed a single fowl for a year is worth about ten cents. Such of the food as is collected by the animal itself left over and above the making of the rich egg, would add somewhat to this estimate. By averaging the tests made of a number full-grown fowls at two different periods, I find that a single fowl will drop under the roost a bushel of fresh manure in a year. This will shrink to about one-half, when it is in the condition in which it is generally used, thus doubling the value it had when fresh, and

making it worth from 20 to 25 cents a bushel. This I consider a fair value of good hen manure as found in the market; 20 to 25 cents per bushel, or from 55 to 60 cents a barrel.

For many years I bought the hen manure in my neighborhood, — from 50 to 100 barrels, — collecting it from house to house, and paying at first $1 per barrel for the same. I was soon satisfied that it was not a paying investment, as much of it had various wastes of the coop mixed with it, such as the old nests and more or less of earth on which it usually dropped. I afterwards reduced the price to 75 cents. per barrel. To collect a dozen barrels of it took two men and a horse a day; after which the sticky mass had to be composted, bringing the final cost to about $1.12½ per barrel. I tested it side by side with equal values of guano, strewing each in the drill. This experiment is worth trying, just to enable us to realize the advantage of handling commercial fertilizers over hen manure even in its finest state. Before applying it to crops it is usually composted with muck, or dryish soil. I don't think there is any argument for this founded on its tendency to burn; its strength to injure the larger varieties of seed, when in direct contact with them, — such as beans, corn or squashes, — as I have planted these, using hen manure without mixing in hill or drill; but it can be distributed better if it be first composted, especially if it is wet and sticky. In composting, I have used about three parts earth to one of manure, beginning with a layer of soil about three inches deep, and alternating to the desired height, ending with a thin covering of soil. The manure should be knocked up as fine as possible; a rake is best if it is sticky. After a few days heat will be developed; then, waiting three or four days more, pitch the heap over, mixing everything well together and fining any lumps that may show themselves. A six-tined fork is a good implement for this. Cover again with soil, let it heat again, and again pitch it over, covering as before with soil.

The Chairman. Now, gentlemen, we have an hour and a half to discuss this subject of the value of manures. Is there any question which any gentleman would like to ask Mr. Gregory?

Mr. Fiske of Framingham. What do you consider the value of unleached ashes per bushel?

Mr. Gregory. We have a very able chemist here, who has all these things at his tongue's end. I can merely give an opinion. I should value them at about twelve or fifteen cents a bushel. Ashes vary in quality; they are not alike. I should be willing to give that for them.

Mr. Fay. I buy hen manure by the barrel, and I think mine is pure. I mix it with meadow muck. I have one place where the muck is eight or ten feet deep. I have never analyzed it, so that I do not know anything about its composition, except as I judge by experience. I dig this muck and let it remain on the surface two or three years before I use it. Fresh muck put into the hogpen under your barn is worth nothing; but let it lie until it becomes air-slacked, and then put it under your barn, and it will be valuable. I find that this muck, mixed with hen manure, makes a compost which has great value. I do not pretend to know anything about it, except from observation.

Mr. Grinnell of Greenfield. There is one very important question for us to consider, and it is a very important element in Mr. Gregory's valuable researches; and that is, how much in value of the manure remains in the land after taking off any one crop. I should like to ask him if, from his researches, from his reading, or from his experience with fertilizers, he can give any reliable estimate of the quantity of manure that remains in the soil after taking off any given crop, whether it be corn, potatoes or tobacco?

Mr. Gregory. That is a very hard question to answer. The Germans answer it in this way, as I am informed on good authority. They keep an account with their land. They put on so much manure, and charge the land with the elements contained in that manure, as determined by analysis; and when the crop is taken off, they credit that land with the elements contained in that crop, and when they strike the balance between the two, they have just what remains of the manure in the land. There being a certain amount of phosphoric acid, nitrogen and potash in the manure, and a certain quantity of the same elements in the crop taken off of the land, those quantities being determined and the amount of

one subtracted from the other, the balance shows the amount of those elements left in the land. We may pursue the same method. We may know the elements of the fertilizers which we apply to various crops, and those crops may be analyzed, so that we shall then have within our reach the means of knowing just how much of the manure applied to the land went into the crops; and when we use barnyard manure, we can get at the elements very nearly by knowing what the animals are fed on. It is well to bear in mind, in these discussions, that there is no such thing as waste phosphoric acid or potash. The ground is an excellent storehouse. Whatever is not taken up this year by the crop remains in the land stored up for future crops.

Mr. Hunt. I have experimented in raising corn, and I have found that corn does much better on cow manure than it does on horse manure. Now, if the milk takes a certain quantity of that plant food, why does the manure from a cow produce better corn than horse manure, if the same plant food comes from the horse that comes from the cow? And if there is more comes from the horse than from the cow, if the plant food is taken up in the milk, how does it happen that the crop is better from the cow manure than from the horse manure?

Mr. Gregory. Two times two must make four, the world over. The gentleman may put a conundrum which I cannot solve, but the truth that other things equal, the fertilizing elements in the manure *must* equal those in the food minus those taken up by the animal is as sound as mathematics; the horse manure is inferior to the cow manure, because though the ingredients in the cow manure become plant food more slowly they continue to feed the crop later. As I understand it, cow manure decomposes slowly, so that the food for the plant is made up as the plant wants it; whereas, the horse manure is ready for plant food at once and therefore starts the plants earlier, but the ammonia that is not used passes down, and very likely it may pass down beyond the reach of the plants, especially those the roots of which grow near the surface.

Mr. Hersey. In regard to accounts being kept of what is applied, I would like to inquire whether we must add as

much nitrogen to the soil as our crops take out, or whether there is not a portion of nitrogen that is found in our plants that is obtained from other sources than from the manure or fertilizer that we apply. Should we not make some distinction in regard to that?

Mr. Gregory. That is a matter which is being largely discussed by our able chemists, as to how much nitrogen plants are able to take from the air and the soil. It is an unsettled matter. We know this much; we know that certain plants get more nitrogen than we give them. For instance, it is said by some that corn gets three parts of nitrogen when we furnish one; but in repeating crop after crop, as the nitrogen left is continually wasting by soaking down into the subsoil and running off in the drainage, we consider it used up, and expect to give the plant what it wants every year; whereas, with phosphoric acid and potash, our accounts might show still a balance in the land.

Mr. Cushman of Lakeville. It was only last week that the president of a farmers' club in my part of the State was speaking to me upon this very subject, the quantity of plant food that was taken from the soil by certain crops, and he remarked that he thought his club had arrived at some very interesting and valuable conclusions through a series of experiments which had extended over five or six years, and he gave me in detail some of those results. I asked him what had been the rule adopted as to the proportion of manure or plant food applied, which had been exhausted in the different crops grown; and he said at the commencement they had adopted the rule, which they had followed right through, of estimating one-half the barn manure and the whole of the commercial fertilizer applied; that the crop had been charged, right through all their experiments of five years, with the whole of the commercial fertilizer applied and one-half of the barn manure. I said, "Supposing, for instance, that two men have applied five cords of barn manure to the acre and planted that acre to corn, one man getting a crop of twenty-five bushels and another man fifty bushels, has each man reported the crop as taking one-half of that five cords, — two and a half cords of manure?" "Yes." It seems to me that a series of experiments conducted under such a

rule as that can be of but very little practical value; and I am rejoiced to hear it put forth, in such plain, decided terms as we have heard this afternoon, that the plant food taken out of our land corresponds to our crop, and that the plant food that comes out of an animal corresponds to the food that goes into the animal. It is a circle, the elements passing through the animal and through the soil, and we take out of one only what we put in the other. The same rule applies to both. It seems to me that it is high time we acknowledged the fact, that we take out of our soil double the plant food in raising two bushels of corn that we do in raising one.

Mr. PATRICK of Boston. The speaker before the last raised a very interesting and very practical point which has not been fully answered, and it is such an important one for the farmers that it seems to me a few more words ought to be said upon it. That is in regard to the sources of nitrogen outside the manure that is put upon the land. How much nitrogen do you get from sources outside from your manure? That question can be answered only by experiments, and such experiments have been made. I cannot from memory give the experiments made in this country, but I recollect the result of experiments made in England, and I think also in Germany. The results of the two were about the same, and they were as follows: That the nitrogen that came down in rain from the atmosphere amounted to from seven to ten pounds per acre for a year; and that is the only source I know of for nitrogen outside of manure applied to the land. A pound of nitrogen being worth say fifteen or eighteen cents, every acre of your land receives every year one dollar and fifty cents or one dollar and eighty cents' worth of nitrogen, and that is all that it can receive, outside of the manures applied.

The question also involves this: How much does the land retain of it? Does our land retain much nitrogen besides what is put on in the manure? The experimenters have found this to be the case, that unless crops are growing all the time, — that is, unless there is warm weather all the time, when only crops can grow, — not only this nitrogen which is applied in manure, but that which comes in the air, is all the time going off; and a great deal more goes off by natural

drainage in ditches than comes from the atmosphere. That is the point I want to bring out; that in our ordinary agricultural operations the nitrogen must necessarily drain away, and that the quantity drained off is considerably more than we receive gratuitously from the hand of nature. And they have also found that land left fallow, without any crops growing on it whatever, will lose from three to ten pounds of nitrogen per annum, and that is a very serious matter. I think that is about what the question called for, and it is a very important fact to bring out.

Mr. Hersey. This is a subject which I confess, at the outset, I do not know much about, and I would like to get some light. I could hardly agree with the gentleman who has just taken his seat. I think that experiments which have been tried show pretty plainly that land is enriched with nitrogen by growing a crop of clover. I think that experiments which have been tried show that a crop of clover is grown without drawing nitrogen from the soil, and that the roots and tops of the clover contain a very much larger portion of nitrogen than was to be found in the soil previous to the time that the clover was sowed. That I think is a statement which has been made on pretty high authority. And I think that there have also been experiments tried which show very plainly that there is a difference in crops; that wheat, for instance, draws a very much larger proportion of its nitrogen from the soil than some other crops. I confess, sir, that we are somewhat at sea on this subject, as well as upon others; but it is an important one, and I would ask the question of the gentleman, knowing very well that he can answer it as well as any other person we have present, as to the percentage of nitrogen which we should allow in making up our formula. I think the question has been partially answered, and yet I think there is a chance for us to learn a great deal more in regard to this nitrogen matter. I feel, when I buy nitrogen and pay fifteen or twenty cents a pound for it that possibly I may be paying too much, and that there may be some easier way by which we can obtain it than by buying it; and it is my impression that you can furnish nitrogen to the soil at a less price, if you can turn under frequent crops of clover, than you can by buying it in the market.

Mr. Bigelow of Framingham. I want to ask a question in regard to nitrogen from the air: whether it is absorbed into the soil and then passes into the plant, or whether a portion of it is absorbed by the foliage of the plant when it is growing? If I understand it, the leaves perform, during the night and the daytime, different offices. The idea has been that it is absorbed, to a large extent, from the air through the foliage. In the case of the clover, I know that in Pennsylvania, where I travelled several years, they turned under large crops of clover, and the land was very much enriched. I tried that experiment. I raised a crop of clover and turned it in, and received but very little benefit.

Mr. Gregory. I would like to make one remark just here, which was suggested to me by the friend who spoke with regard to clover, and who brought out a practical point. He stated that he had applied plaster for a series of years and finally got no result from it. Plaster is not a fertilizer, and of course there was an end to that as plant food. If it had been a fertilizer, and he had gone on applying it from year to year, he would have got a crop of clover all the time. But it was not a fertilizer; it merely acted to free all the fertilizing elements in the ground, and when it had freed all there was there, then there was no response.

There is no man in the United States, or under the sun, who can answer these questions better than Prof. Goessmann and he ought to tell us all about it.

Dr. Goessmann. It is well understood that plants get nitrogen compounds from the air; therefore, foliaceous plants increase the nitrogen in the soil at the expense of the air. Clover, turnips, beets, and other large-leaved plants, leave much more nitrogen in the ground than the crop takes. For these reasons, the foliaceous plants are of the utmost consequence in the operations of the farm.

Mr. Myrick. There are one or two questions about this fertilizer matter which we meet very frequently. One is the question whether fertilizers exhaust the soil. We have had it very plainly expressed to us, this morning, that barnyard manure and commercial fertilizers are identical, so far as the nitrogen, potash and phosphoric acid which each contains are concerned. But the farmer will say that the barnyard

manure also contains a large amount of vegetable matter; that it is necessary to apply this vegetable matter to the soil in order to keep up its fertility; and that the continued application of commercial fertilizers, without the addition of much of any vegetable matter, will in time run out the soil. I think the best experiments in this direction, and the longest continued, are by Lawes and Gilbert of England, with which we are all more or less acquainted. I have Dr. Lawes' report for this year, on his wheat crop. He has grown wheat on the same land for thirty or forty years in succession, including the year 1885. Part of the land has been unmanured, part has been manured with barnyard manure, and part with chemical manures only. Now, I find by his statement in the English "Agriculturists," that the average crop of wheat for thirty-three years, not including this year, on the unmanured land, has been at the rate of thirteen bushels to the acre; on the land to which barnyard manure has been applied, the average crop during thirty-three years has been thirty-three and one-half bushels; whereas, the average crop where the chemical manures have been applied has been thirty-five and one-quarter bushels. That is to say, the wheat grown on the same land for thirty-three years in succession has averaged two bushels an acre more, where chemical manures were used, than where barnyard manure was applied. But the crop of the present year brings out another point. The crop of 1885 on the plot where barnyard manure was used was forty bushels, and on the land where chemical manures were used the crop was only thirty-three bushels. That is to say, the barnyard manure gave seven bushels more than the chemical manure. So a farmer who had only that one year's experience before him would say, "I cannot afford to use chemicals, because barnyard manure will give me seven bushels more to the acre than chemicals." But if you look at Dr. Lawes' full report, you will find that he explains this great difference by the difference in temperature and the wetness of the early spring season. Last spring in England was wet and cold, and the variation was so great that he attributes this remarkable difference between chemicals and barnyard manure to the climate and not to the chemicals.

I think these experiments demonstrate most conclusively

that it is not necessary to add this humus, on which we have placed so much value, to the soil; that the main thing is to apply nitrogen, phosphoric acid and potash, and not to haul on a lot of muck or straw, or anything else of that kind. The plant requires those three elements, with a sufficient amount of vegetable matter and cellular structure in the soil to support the crop; and if it contains those elements of plant food, in such shape that the plant can get hold of them, a good crop will be the result.

Mr. Gregory. There is a nice point which I would like to meet in this way. My foreman was down to see me last winter, and, speaking of one of my farms, he says, "I think you better have barnyard manure on your land." We had had night soil on it (which is a good deal like a commercial fertilizer, in the fact that it has but little humus in it) for perhaps twelve or fifteen years. I said, "I know it, Frank; what do you propose?" Why did he say "You want barnyard manure on your land?" I will tell you. It was because the soil bakes so hard, with a continuous application of night soil, that it wears out the best tools pretty fast. You will always find that trouble if you use night soil, and I suppose it is the same with concentrated fertilizers. Now, the application of humus to the soil prevents that; it puts the ground in such condition that it does not bake. I said to myself, "I must have barnyard manure there, or else lay it down, so as to form humus by the roots of the plants turned over." It is not necessary to have barnyard manure; but we must have something to prevent our land from baking. What is humus? It is decayed vegetable matter. You can get it without barnyard manure. Muck is the thing. Scatter it on your land, or lay your land down to grass or rye, or the like of that, and plough it under, and you have got humus.

Mr. Daniel Stratton of Hudson. It has been represented here that by spreading manure we lose very little. I would like the speaker's opinion on the effect of fire-fanging horse manure. Do not some of the fertilizing elements escape from that?

Mr. Gregory. Yes, sir; the ammonia is supposed to pass off. I buy fire-fanged manure because I can get it cheap, and I know that potash and phosphoric acid are not

volatile; all that can change in the manure is the ammonia. I go to Gloucester and buy up cheap fish stuff, which I mix with this fire-fanged horse manure, and that decaying fish restores the ammonia which has been lost. I am using from fifty to one hundred tons of fertilizers a year, and I will tell you how I have found an advantage in using nitrate of soda. This year I had fourteen acres of onions. I raised them wholly on fertilizers, and have for years, and have secured good crops. My onions came along and got ready to bottom, and I saw that one piece, which had been well manured, I thought, stood still. All onion growers know that when onions begin to bottom vigorously they show a little white on the neck. The onions on the piece to which I refer did not show the white. I took about three hundred pounds to the acre of nitrate of soda and applied it each side of the rows, and I got a nice crop of onions. There is nothing else that I can think of that could have affected them but that nitrate of soda. It is a very perishable thing, as we all know. It tends to go down freely. It will not do to apply nitrate of soda where there is any danger of water to carry it down more than two feet, out of the way of the plant.

Now, about these fertilizers. The gentleman presented the matter very well indeed who spoke about the experiments by members of a farmers' club, where they charged the first year only one-half of the barnyard manure to the land and charged the whole of the fertilizer. That may be all right. Barnyard manure does not become available the first year. The elements are all there, but they are not readily soluble, and they remain in the ground. It is the best argument in the world for using fertilizers, that they are all going to be used up this year. What do you use them for? You are not going to use them for next year. As long as I am farming for this year, if any of my manure goes over, it is of no account. If you are going to lay down grass land, and want it to stay, it is well enough; but if you want to grow crops, whatever goes over is of no value to us. We don't know what we may have there next year. I can tell any man who says that a fertilizer only lasts one year, that he does not understand what a fertilizer is. He has lost the primitive idea of a fertilizer. It is just as good manure

as barnyard manure. Why don't it go over? Because you expect to get your manure at about half the cost of barnyard manure, and you do not put on enough to go over. If you will put on just as much as you do of barnyard manure, I will guarantee that just as much will go over. Why do I say that? Because, if you have a small quantity of phosphoric acid in your land, you can put on just as much nitrogen and potash as you please, but the measure of the crop will be the amount of phosphoric acid in the soil. It cannot grow more than the phosphoric acid will furnish, and the nitrogen and potash will be left. Now, suppose you want anything to go over; you may put on the average quantity of nitrogen, and then put on double the corresponding quantity of phosphoric acid and potash, and I will guarantee you will have part of it go over.

Mr. Wheeler. Do I understand the lecturer to say that the phosphoric acid will not disappear from the soil in any way except as taken up by plants?

Mr. Gregory. That is the way I understand it. It is one of the hardest things to get out of the soil. Carbonate of lime will go down, but phosphoric acid will not.

Mr. Myrick. This brings up another point on which I would like to ask your opinion. We find that our fertilizer manufacturers send out their cards, and they aim to give us a very high percentage of soluble phosphoric acid. Now, practical and scientific experience seems to point to the fact that so soon, or within a day or two after this soluble phosphoric acid has been applied to the soil, it reverts; that is, it gets into a partially insoluble condition, — it becomes reverted phosphoric acid. Why, then, should we pay an extra high price for the soluble phosphoric acid, when the reverted acid may be expected to be as good? Do you think that reverted phosphoric acid is worth as much to raise a crop as soluble phosphoric acid? There is a difference of one or two cents a pound now, and formerly it was a good deal more.

Mr. Gregory. If I understand right, the reverted acid is an accidental product; I do not think chemists aim at it. The gentleman is right about the reversion in the ground, but there is this difference; it has been got into a state fit

for plants, and when it reverts it is in such a state that it can be easily made food for plants. You see it is increasing in value. I do not think there is much difference between them. I think it is a sort of by-product. I don't suppose they aim to have it reverted; they aim to have it soluble.

Mr. LINDSAY. Quite a number of practical points have come up here which perhaps we may discuss at length. First I will say a word about phosphoric acid in its different forms. Formerly farmers used to have a very favorable opinion of soluble phosphoric acid, in preference to reverted; but according to the experience which has been derived from experiment, it is now generally held that reverted phosphoric acid is nearly the same as the soluble. From what opportunity I have had for observation, I hardly think that is so. In a great many cases reverted phosphoric acid will not act as quickly on the crop as would soluble phosphoric acid. I have had considerable experience with reverted phosphoric acid; that is, what is known among chemists as "chemically reverted." I have derived this phosphoric acid from steamed bones, where the bones have been boiled or steamed under pressure and made very soft, so that you can crumble them with your fingers. You will find a great deal of phosphoric acid in them. But from my experience, and what opportunity I have had for observation, I have come to this conclusion, that it does not act as quickly as soluble phosphoric acid; that soluble phosphoric acid may perhaps act at once upon the crop, whereas, if reverted phosphoric acid is put upon land, it will not come into action for perhaps a month or six weeks, to any great extent. I know that scientific men claim that there is very little difference, and that if soluble phosphoric acid is put on land, if it is not all taken up at once (and of course it is not), it goes into the reverted form; but from what I have seen, I think that reverted acid does not act as quickly.

Nitrogen or any ammonia compound is injurious if we apply too much. All those who have studied with any interest Prof. Atwater's experiments have seen how on different soils different ingredients were needed. Phosphoric acid applied on some soils did wonderfully, and other materials, such as potash or ammonia, seemed to amount to nothing at all, simply

because the soil was lacking in phosphoric acid. The valuable series of experiments now being conducted at Amherst. of which we shall hear later on, also corroborates this theory. There they exhausted the soil as far as they could by growing certain crops upon it, and then applied artificial manures or fertilizers; and they found, if I understand correctly, that the only thing that seemed to do any good in that place was potash. Where phosphoric acid or ammonia was applied, they could not raise a good crop of corn; but when they applied potash, they had a good crop of corn. Why was that? Simply because the soil had got to a state where it was lacking in potash. I think a great many farmers do not understand the fertilizer problem and the problem of feeding plants. Because one phosphoric acid fertilizer may fail in one case, it does not show that phosphoric acid fertilizers are of no value; it is simply because we do not understand what the land needs.

I was very much interested in the remarks as to the value of nitrogen and where it comes from. Probably Dr. Goessmann will bring it out quite clearly in his discussion to-morrow. I will simply say, that so far as scientific investigation gives us any light, a certain amount of ammonia comes from the soil; that is, from the vegetable matter in the soil. That vegetable matter, decaying and breaking up, yields us a certain quantity of ammonia. There is another quantity, as our friend has said, that comes from the air. Especially if there has been no rain for a long time, and then we have a shower, there is a certain quantity of ammonia and nitrates developed by the electricity in the air, and the water washes them down and carries them into the soil. There is where clover gets a large amount of its nitrogen. As far as we know, there is a very small amount of nitrogen or ammonia coming from the air taken up by such plants as clover, and perhaps all plants take up more or less; but that amount, as far as we know or as yet have been able to demonstrate, is very small. But clover, you will remember, is a very deep-rooted plant; it sends out its millions of roots all around everywhere, and penetrates away down into the soil. Those fibrous roots, going down so deep and spreading out to such an extent, gather up large quantities of ammonia. There is

where we get a great amount of it, I think; and perhaps that is a point which has been somewhat overlooked.

Mr. PATRICK. I wish to say, in that connection, that I spoke of the rain as bringing down ammonia. So it does. It is well known, however, as the last speaker has said, that in addition to that, there is a very small amount of ammonia taken up by the leaves. That I omitted to say. But the general fact remains, I think, that very nearly all the nitrogen of plants comes from the soil. That is what I intended to make perfectly clear before.

Mr. LINDSAY. There is just one more point on which I wish to speak, and that is in relation to the question whether or not there is any waste in applying manure. Potash and phosphoric acid, as has been already said by the gentleman on the platform, are held by the soil; that is, they do not escape; they cannot become volatile; neither do they descend and go off in drainage water to any preceptible extent. They remain in the soil and enter into various chemical combinations. The action of ammonia is somewhat different. It is supposed that nitrogen, before it enters into the plant, must undergo what we call the process of nitrification. That is not a settled fact yet, but it is held by a great many scientific men; and it seems to me that it is going to be generally agreed upon, by and by, that nitrogen goes through what we call nitrificaton, and comes out in the form of nitric acid, and in that way enters into the plant. The nitrates are very soluble, as of course we all know who have used fertilizers to any extent, or who have used nitrate of soda. There is where we have got our principal nitrates, and it goes through the soil very quickly. Experiments have been made, especially in England, which go to prove that there is a large mass of nitrogen in the form of nitrates which leaches out through the soil. This has been proven by direct experiments; and in Holland, where they carry on agriculture to a very large extent, they make it a point to cultivate their land all they possibly can, — to keep something growing there all the time, — in order to prevent the loss of any nitrogen or any of the nitrogenous material. If they do not keep it in a state of cultivation they claim, and very justly, that a portion of the nitrogen in the form of nitrates goes down and leaches through

the soil and is lost. And Dr. Lawes also recommends that we should let our land lie idle just as little as possible; in other words, keep something growing on it all the time, so that instead of losing this plant food in the form of nitrates, we should save it and have it in our crops.

Mr. Myrick. Before Mr. Lindsay sits down, I think it would be a good idea for him to explain to us the difference between ammonia and nitrogen. That is something which is not clearly understood by a great many farmers.

Mr. Lindsay. It is not necessary to go into a very lengthy chemical explanation; I will simply say this: Ammonia and nitrogen bear the same relation to each other as 14 to 17. Ammonia is a combination of hydrogen and nitrogen, which we chemists express by the formula $N^1 H^3$. In other words, three parts of hydrogen and one part nitrogen make ammonia. Now, if we should reckon nitrogen 14 and call ammonia 17, any one can figure out from that any percentage he may desire. That is, if we should take three per cent. of nitrogen, we would have nearly three and one-half per cent. of ammonia; nitrogen being simply that element, and ammonia consisting of a chemical union of three parts of hydrogen and one part of nitrogen. And when you smell what we term "ammonia" from a pile of manure or anything of that sort, it is not the nitrogen going off that you smell, but the ammonia; it is nitrogen in combination with hydrogen. A great many fertilizer manufacturers prefer to show their formula in ammonia rather than in nitrogen, because it shows a little larger; but the amount of actual nitrogen is precisely the same.

Question. Does not the ammonia going off depreciate the value of the fertilizer?

Mr. Lindsay. Most assuredly. You do not want to lose one particle of that, because you are losing just so much plant food Phosphoric acid is nine cents a pound, potash four and a half cents, while nitrogen is reckoned at eighteen cents a pound. You see that that is the most valuable ingredient, and of course you do not want to lose any of it.

Secretary Russell. I hope it will not be given us to understand that the *smell* of manure is any indication of its value. Is that so, Mr. Lindsay?

Mr. Lindsay. Yes, and no. That strong smell that comes from manure, as I understand it, comes very largely from organic acids. We have a series of acids which come off, which are probably of no practical value. But in addition to that, you will find that that strong smell is given off, to a considerable extent, by the ammonia. I have smelt the ammonia, in a great many instances, when I have been into a barn.

Question. Is the manure losing when you smell it?

Mr. Lindsay. Yes, sir; I should say it was.

Secretary Russell. A dead crow hung up in the middle of a cornfield, with the wind blowing from him, will drive a man out of the field; but the whole crow, smell and all, would not manure more than one hill of corn. I do not believe in this smell theory. I think there is more humbug in it than anything that has come before this meeting. When this nitrogen discussion came up I thought of the title of Mr. Gregory's paper, "Errors in Estimating the Values of Manures," and my mind ran back very readily to the first meeting of this Board which I ever attended, when the discussion of nitrogen came to this point of absurdity: that, if you analyzed your soil and found that it was so poor in nitrogen that it would not be worth fifty dollars an acre, and you put in a crop of clover and allowed that clover to sufficiently mature, so that the leaves were filled with nitrogen, and turned it under, and the next year analyzed the soil, and took the amount of nitrogen in it at seventeen cents a pound, you found the soil worth five hundred dollars an acre! Prof. Goessmann, Mr. Slade, Capt. Moore, and others here, will remember that occasion. That was the end of the nitrogen discussion. Almost everybody started for the door when it got to that point, and we are near there now.

Mr. Lindsay. I want to give my idea, which was not exactly understood. My point is this: the smell which comes from decaying organic matter, and which is the result of organic acids, does not indicate the loss of any manurial value; but if you smell ammonia going off from a fertilizer, you may know you are losing something. If you smell a dead crow, or anything else, if you cannot smell the ammonia you are not losing anything; but where there is active

decay going on, as in a pile of manure, if you can distinguish it as ammonia by the smell, then you may know you are losing ammonia every time.

QUESTION. Can you smell the ammonia unless artificial heat is being generated?

Mr. LINDSAY. Artificial heat causes it to go off.

Mr. SESSIONS. We farmers, who get out manure, do not know the smell of ammonia. We know barnyard manure smells very strong when we are getting it out of the yard. What I want to know is whether the smell of ammonia is different from the smell of barnyard manure?

Mr. MYRICK. Did you ever smell hartshorn?

Mr. SESSIONS. Yes, sir. I do not know that we need a chemical lecture to tell us how to smell. The experiments, the results of which are mentioned here, I conceive to be of no value at all, and to illustrate my position I want to give a bit of my experience. A few years ago I applied fish potash on quite long rows of potatoes, and I had five or six rows where the potash was not used. When the potatoes were dug they were all left on the ground together. Myself and my father and half a dozen men looked them over, and we all said there was not a particle of difference between the yield of the rows where the fish potash was used and the others. We took the number of pounds, and we found that, if potatoes were worth seventy-five cents a bushel, we had got enough from our fish potash to pay for it; and yet, on looking at them, we could not see one particle of difference. The point I want to make is this: that guessed-at experiments are not worth stating; our time ought not to be taken up with the recital of them.

Mr. PATRICK. I will ask the speaker of the afternoon with regard to the fish that he has used.

Mr. GREGORY. That is an immense question. We use fish for everything, more or less. I have a carload of fish now; what I call "fish chum." I put it on all my onion land and on my cabbage ground. I have used it for years. Some years I have used eight or ten tons of solid fish. We depend upon it largely for ammonia, and more or less for phosphoric acid. The fish-waste — the skins and fins — we buy very cheaply. We use that on cabbage. It is the

cheapest source we have, I think, for ammonia and phosphoric acid, — principally ammonia. We get the fish skins, etc., for about five dollars a ton, sometimes cheaper; and liver chum for four or five dollars a ton; porgy chum for from $6.50 to $7.50. Our fertilizer manufacturers (I tell it *sub rosa*) depend largely upon that. I don't know what they would do for ammonia without fish waste. Fish must be decomposed, you know, before it is ready for use as food for plants; but the fleshy part decomposes very easily. The bones take about two years; but when I am going to follow with fish on the same land, year after year, I figure it, bones and all, on that land. After the first year, I figure the phosphoric acid in the bones as available, as well as the ammonia in the fish itself. It is very strong indeed.

Mr. SLADE. I understood the gentleman to say that he grew his onions with fertilizers.

Mr. GREGORY. When I say that, I should say that I call fish among the fertilizers, — concentrated waste, — in distinction from barnyard manure.

Mr. SLADE. Don't you use some phosphoric acid?

Mr. GREGORY. I put fish on in the fall, so as to have it decompose all it can; and in the spring I use the potash, phosphoric acid and ammonia of the fertilizer manufacturers, that I find in the market.

Mr. SLADE. Would you be as willing to apply your phosphoric acid in the fall as in the spring?

Mr. GREGORY. Yes, sir; I would. There is no waste; none of it goes down. I apply fish in the fall, because it has a chance to decompose. I use ashes in the fall, so as to assist the decomposition. I will give you, here, a hint that may be worth something to you in growing a crop of cabbage. Plough under a hundred bushels of unleached ashes. That will cost twenty-five dollars. The next spring take fish waste, say one-third, and compost it with soil; plough your land and spread broadcast your compost, and harrow it, as I do. That will give the furrows a little extra amount of fish. Then put in your cabbage-drill and plant your cabbage, and it will do first-rate.

Rev. L. R. EASTMAN, JR., chairman of the school committee and chairman of the trustees of the town library of

Framingham, extended a cordial invitation to the members of the Board, and others in attendance upon the convention, to visit the public library and other institutions of the town, at their convenience.

(Capt. J. B. MOORE of Concord, in the chair.)

Secretary RUSSELL. I regret, exceedingly, that Dr. Billings is not present to read the paper announced upon the programme, on "Tuberculosis in Cattle," and to answer such questions as you may wish to ask, after you hear it. Dr. Billings is a native of Massachusetts, was educated in our schools and in Germany, and came back to Boston, where he entered upon veterinary practice and into intimate association with all the investigating medical faculty. Last spring he went back to Germany for a special course of instruction, under Professors Virchow, Gerlach and Koch, and on his return he had certificates from those eminent professors in their special branches of medical science, that he was the ablest student, from this country, who had been under their charge. He is radical in his views, as you will see, and probably far in advance of our ideas upon these topics. However, we may change our minds in the light of his science.

TUBERCULOSIS IN CATTLE.

BY FRANK S. BILLINGS, V. S., OF BOSTON.

Those diseases which we have constantly with us, and which we have come to consider inevitable evils, pass with but casual notice; but if a pest threatens us, or a locality is suddenly attacked by some disease, then the whole population is alarmed, and ready to sustain reasonable and unreasonable action.

We cringe before the small-pox or cholera, because they strike us suddenly and quickly; but neither of them, or both of them together, can, at the present day, cause the desolation created by pulmonary consumption in any term of years, — the world's death rate from this cause alone being from one-seventh to two-sevenths of all deaths.

Tuberculosis of cattle is the full and inbred sister of the

disease in man; and, as will be shown, can also be considered as one cause of the disease in man.

Hence, above all our animal diseases, there is, in reality, no one which should so earnestly appeal to our intelligence for preventive and restrictive legislation as this.

It is singular that it is also about the only disease of cattle that is transmissible to our own species through the food we eat. It, again, is of especial instructive value to all hygienists and legislators, and above all to breeders, in that veterinarians have collected the very strongest evidence of the value of heredity and contagium with reference to bovine tuberculosis,— evidence that is equally applicable to man.

The long continued efforts of the investigating pathologists of the world have conclusively shown that there is but one disease that should be known as tuberculosis; that it is one and the same disease wherever found in the animal kingdom; that it is a contagious infectious disease, finding its original habitation in the human and bovine species, but is transmissible to every form of warm-blooded life; and, finally, that its cause is one peculiar specific bacillus, discovered by Robert Koch of Germany, and that this bacillus has a peculiar reaction to specific methods of coloring that is not possessed by any other bacteria that occur in the animal organism under the same conditions. Hence it will be seen that the mere presence of a small nodular body in an organ, even in great numbers, that correspond in every outward characteristic to a tubercle, by no means constitutes what we now term tuberculosis.

The other varieties are classed as "Pseudo-Tuberculosis," and occur in almost every variety of animal life. In sheep it is due to a peculiar thread worm, "Strongylus filaria," and in calves to another, — S. micrurus. In both cases the animals affected perish of what is technically termed "marasmus,"— a form of consumption; but while the chief lesions of disease are also in the lungs, we do not find any of the broken-down conditions and formation of cavities that occur in the same organ in human consumption.

Bovine tuberculosis offers us even more direct, or at least more accurately collected, evidence of the influence of

heredity and contagium than has as yet been collected by medical practitioners.

It must be borne in mind that the same cause is asserted to exist in this as in human tuberculosis; hence, from this point of view, both diseases may be looked upon as a unit.

While the bovine disease has been known to veterinarians as well as to breeders for a long time, it did not attract any great attention from hygienists or investigators into the cause of disease, until it began to dawn upon their minds that tuberculosis was an infectious disease. This interest was greatly augumented when it was proven that the milk of cows having tuberculosis could cause the same disease in young animals. With the discovery of the specific bacilli in the lymph cells, and still more recently in the circulating blood, and with the positive evidence of its contagious character, it can be safely asserted, that, aside from its importance from an economical standpoint to the cattle interests of the country, from those of public health there is no disease of our animals the importance of which bears any comparison with bovine tuberculosis, not excepting trichinæ in swine.

As the points which I desire to place emphasis upon are solely those of the relation of bovine tuberculosis to the welfare of the State from an economical and hygienic point of view, I can well be pardoned from leaving out of consideration any discussion of its symptomatology at present, particularly as most cattle men are, practically, quite well acquainted with it.

The Extension of Tuberculosis in American Cattle.

In the following remarks it must not be understood that I am entering upon a causeless polemic against our public authorities. I regret to say that we have had, and still have, a very great and dangerous evil among our cattle, which has been utterly neglected.

One of the first steps necessary to be taken is to protect the public by suitable hygienic laws, and to this end, a code of veterinary police laws and a well organized veterinary police force is one of the first necessities; then neither cattle

owners nor the public have any right to blame those appointed by the Executive to represent their interests as best they can.

With neither laws, men or means at their command, suitable to the purpose, it is but natural that the best intentions can only be followed by very unsatisfactory results.

That State which first makes an intelligent move in this direction, and thus demonstrates what can be done, will confer a blessing upon the whole Union. It is to be hoped that Massachusetts will be that State, and hence be true to her reputation of always watching carefully over the welfare of her citizens.

Personally, I know nothing about the extent of tuberculosis among American cattle, yet, as already said, I venture the assertion, that the annual losses caused by it far exceed those of all other bovine diseases put together.

From the general tone of conversation among veterinarians and breeders, it would seem as if it prevailed more in Jerseys and other thoroughbred cattle, than in the mixed breeds; but in Germany it seems to be limited to no particular breed.

What we desire to know, and what the State should tell us, is:

1. To what extent does tuberculosis prevail in our cattle, and the exact proportion in each State?

2. Is there any evidence that climatic, telluric, geographo-topographic conditions exert the same influences on bovine tuberculosis that they do on human?

(The same is true of food, stabling, care, etc.)

3. Does any particular pure breed seem to have a natural predisposition to it, and if so, which?

4. Does grading or out-crossing tend to lessen this tendency?

5. What is its proportion between pure breeds and so-called natives?

6. What evidence have we of its extension by the cohabitation of a tuberculous animal among healthy ones in the same stable, — contagium?

7. What are the evidences which point to predisposing influences exerted by heredity?

8. Are such tendencies transmitted more by the bull than the cow, or *vice versa?*

9. What evidence can be gained from practical experiences that the milk from tuberculous cows can cause the disease in calves from healthy mothers, or young pigs, if fed upon it?

10. What amount of milk is sold in the State from diseased or tuberculous cows?

11. What is the annual loss to the cattle interests of the State from tuberculosis?

The only evidence that I can give of American origin is from a Dr. Crundall, V. S., of New York State.

In the "Journal of Comparative Medicine," vol. V., p. 330, he says: "The disease most prevalent among cattle in this district is tuberculosis. I have no hesitation in saying that fully 30 per cent. of the grade cattle in the counties of Seneca and Ontario are affected with tuberculosis. In pure-breeds the percentage used to be even greater, but on account of the losses breeders suffered from it, the herds that used to be kept here have been broken up, so I cannot tell much about it now."

I have made every endeavor to gain information upon this point, and have written to veterinarians who knew of the loss of whole herds from this cause, and the breeders who suffered the loss, but my inquiries have been utterly ignored.

In Germany the disease has finally become a recognized evil, though no State but Bavaria has, as yet, attempted to gain any exact statistics as to its true extent among cattle.

The following statistics are, however, instructive in several ways.

The first attempt made in Bavaria was in 1877, and the percentage of tuberculosis in each thousand cattle examined was reported as 1.62. Of these, —

64	were 1 year old or under, . .	1.31 per cent.
528	were 1 year old to 3 years old, .	10.81 per cent.
1,846	were 3 years to 6 years old, .	37.80 per cent.
2,445	were over 6 years old, . .	50.07 per cent.

For the year 1877 to 1878 the percentage was 1.54 to the 1,000 head.

From Jan. 1, to Dec. 31, 1874, there were slaughtered at Augsburg, Germany, 11,311 cattle of all descriptions; of these 1.18 per cent. were tuberculous.

In 1876 there were killed, 13,241 cattle and 25,909 calves: 250 tuberculous.

Of 231 oxen and 5,290 calves inspected at Munich, before the building of the city abattoirs, 235 were tuberculous.

Again, at Augsburg, 1883, there were killed, 11,829: tuberculous, 3.12 per cent.

I wish, however, to call your urgent attention to the following facts taken from the 1st Annual Report of the Municipal Abattoir at Berlin, Germany.

This institution is a model of its kind. It is under the supervision of a chief veterinary inspector, assisted by 10 chief sub-veterinary inspectors, an inspectors' recorder, and 4 branders; a supervising microscopic expert; 4 division veterinarians; 87 sub-inspectors for trichinæ and microscopic examinations of suspicious flesh; 30 persons engaged in collecting specimens of pork from swine, to be examined for trichinæ.

The institution has fine offices, residences, etc., for the officials; a bacteriological laboratory, and one for the microscopical examinations, fitted up with every necessary appliance. The sheds and grounds are something, for neatness and substantiality, of which no American can form any conception whatever.

Whole number of animals slaughtered for the year 1884:

Cattle, ...	93,837
Calves, ...	78,220
Sheep, ...	171,077
Swine, ...	244,343

Number of butchers slaughtering at the abattoir, 567.

Not an animal can be slaughtered out of it, except horses, for which there is another and especial abattoir, where there is also the same rigid veterinary inspection.

Number of animals of which the whole carcass was condemned: —

On account of tuberculosis,	182	cattle.
" " " hog cholera,	72	swine.
" " " icterus,	38	"
" " " dropsy,	18	"
" " " general bad flesh,	9	"
" " " being poorly bled,	3	"
" " " ecchinococci,	1	"
" " " measles,	1,621	hogs.
" " " trichinæ,	216	"
" " " lime deposits in flesh,	19	"
" " " actinomycosis,	15	"

Single organs were condemned as follows: —

From cattle,	21,229
" calves,	816
" sheep,	4,806
" swine,	7,401

Tuberculosis was found in single animals, the whole carcass of which was not condemned: —

Cattle,	2,613	times.
Calves,	2	"
Swine,	1,313	"

One has but to consider the lessons which such an organized and circumspect inspection teaches, and to compare it with what is done in this country, in order to see how lamentably our governments are false to their public duties.

From it we should learn:

1. That we have, in reality, no meat inspection in the United States.

2. That we do not really know what diseases affect our animals, or to what extent they bear relation to the health of the consumer.

Heredity comes under what physicians call the internal causes of disease, while contagium is known as the sufficient or exciting cause.

The first is much the more important, for without it the second cannot act.

Under internal causes we include all those conditions which are brought about in the animal organism through occupation, feeding, housing or surroundings, or by disease itself, which produce organic weaknesses predisposing the individual to disease in any form.

Hereditary weaknesses are here included.

We have also what is termed a natural predisposition on the part of certain species, — such as, in the equine, for glanders; in the canine, to rabies; in the bovine, to rinderpest and the lung plague; and in men, to measles, scarlet fever, etc. The real nature of such special disposing conditions is entirely beyond our knowledge.

We must bear in mind that it is not absolutely necessary that the parents themselves are actually diseased during their lifetime. They may only possess a constitutional weakness, but they may transmit it to their progeny; and if both parents possess it, the tendency is very likely to be very much increased in the young.

With reference to tuberculosis it may be said, that everything which tends to produce an irritable condition of the respiratory tracts is to be looked upon as exerting a causal effect in producing that disease. As I shall show, the real or exciting cause of this disease is a bacillus discovered by Robert Koch in 1883, which bears his name; yet it can be asserted that where these internal weaknesses do not exist, the bacilli do not find the conditions necessary to their existence under ordinary circumstances. But this always excludes the possibility of a healthy individual becoming diseased through long continued exposure to contagium from living in the same stable with a diseased one.

The biological study of any form of disease-producing bacteria demonstrates that if the cultivating media — internal conditions — are not suitably composed chemically, if they have not the right degree of moisture, if the temperature is not conformable, the bacteria cannot live or thrive.

A vigorous and healthy pair of lungs does not offer these conditions; weak ones do, or may upon very slight invitation. In Europe, the governments forbid the use, for breed-

ing purposes, of animals having constitutional weaknesses. American breeders are slowly learning that they must apply similar principles if they would avoid disastrous consequences. The fact that heredity plays a very important rôle in tuberculosis has long been recognized for our own species.

Louis concluded that it was an essential cause in one-tenth of all the cases he had seen; Lehert in one-sixth; and, when scrofulosis was taken into account, in three-fifths. The same is true of nearly every author that has given the subject consideration.

Johne has demonstrated, for the first time, the presence of the specific bacteria in the noduli in the lungs of a calf that was aborted at the eighth month of pregnancy.

Adam says: "That, although tuberculosis seldom develops in the fœtus, it has been sufficiently proven that a tuberculous cow can transmit the tendency to this disease to its offspring."

Busch — 1880 — demonstrated the lungs of a sucking calf that were full of tubercles In 1878, one such was found at Augsburg; 1880-'85, five such were found at Nürnburg.

Semmer notices five cases of pulmonary tuberculosis in the fœtus (calves). They were all aborted, — one at three months, another at six, another at eight; while the others had just been dropped. He says: "These cases prove to me that tuberculosis can develop in the fœtus during pregnancy."

Jessen found the lungs of a three months old aborted calf full of tubercles. As the tubercle bacilli have been found in the calf fœtus, and in the blood of phthisical human beings, it is now left for us to demonstrate them in the blood of the mother, and in the tissues (or blood) of the fœtus at the time the latter has been aborted.

This evidence is sufficient to show to you that the disease itself, as well as constitutional weakness, can be transmitted from parents to offspring.

We come now to consider the real or exciting cause of tuberculosis, — that is, that it is a contagious disease.

The fact that tuberculosis could be transmitted to animals by means of inoculating them with material derived from

persons that have died of pulmonary consumption, is much older than the fact that the disease is contagious, — that is, can be transmitted from one living individual to another, by more or less intimate social relations, — or that it can in reality be transmitted from parents to offspring, especially by the mother during the period of pregnancy.

It is not in accordance with my present purpose to detail the historical development of the experiments by which these ideas finally gained credence, but rather to limit myself to those given by studies upon bovine tuberculosis, which are of more especial interest here. I have by no means collected all the observations that have been recorded, but rather selected a few that are very much to the point it is desired to emphasize. While considering these evidences as to the especial principle which acts as an exciting cause in constituting tuberculosis a contagious disease, you must never lose sight of the fact that the internal conditions which make infection possible are of still more importance, not only in this but all such disease.

Medicine has its fashions, and the present mode is to hunt for bacteria alone, and to lose sight of the very lessons which this hunt teaches; viz., that the internal or preparatory conditions are far more essential to the completion of the disease than its actual or exciting cause.

The honor of being the first to prove, by direct experiment, that the fluids of the living organisms, or butter secretions, contained some unknown principle capable of inducing tuberculosis in healthy young animals, when fed upon it, belongs to a member of the veterinary profession, — Professor Gerlach, the late Director of the Veterinary School at Berlin, Prussia. If we are to judge by the value of work done to humanity in general, Gerlach was certainly the greatest veterinarian that has ever lived, for no one observation ever made by mortal man is more significant or terrible in its teachings than that the milk of cows diseased with tuberculosis can produce the same disease in young animals, when fed upon it.

Gerlach says: "Having a cow afflicted with tuberculosis, it was resolved to test the question, whether the milk from

such a cow is capable of producing a similar disease in young fed upon it."

The results of these experiments upon quite a number of young animals were partially successful and in part unsuccessful, but they were sufficient to show the dangerous character of such milk as food for human beings, especially babes.

Albert reports a case of practical observation, in which a farmer's wife fed a litter of pigs with milk from a tuberculous cow that was so bad she did not dare use it. The pigs died of tuberculosis as revealed by autopsies.

Bang, however, gives the most conclusive proof of the infectiousness of the milk from tuberculous cows, and shows why such experiments have occasionally failed. In every one of his cases the tuberculous processes had extended to the udder, — tubercular inflammation of the udder, — and in every one of them he was able to demonstrate the presence of the specific bacilli in the milk, before it was fed to healthy calves from healthy parents. Every calf fed upon it died of tuberculosis.

Johne has shown that it is always possible to differentiate between simple inflammation of the mammary gland, or garget, and the tuberculous form, by the microscopic examination of the milk after treating the same according to the prescribed methods for coloring tuberculosis bacilli.

I can confirm this testimony, having never failed in a single case, though I have not seen the cows.

Nocard — Alfort, France — found the specific bacilli in the milk of eleven cows with tubercular mammitis.

Johne reports 322 feeding experiments made with all sorts of tuberculous material. Results: 43.5 per cent. positive, 51.1 per cent. negative. These experiments were divided as follows: —

117 animals fed with tuberculous material from diseased calves: 61 per cent. positive, 34 per cent. negative.

46 animals fed with cooked meat from a tuberculous cow: 13.3 per cent. positive, 86.9 per cent. negative

91 animals fed with milk from tuberculous cows: 30.7 per cent positive, 59.3 per cent. negative.

1 animal fed with milk from a tuberculous rabbit: 100.0 per cent. positive.

25 animals fed with tuberculous material from man: 36.0 per cent positive, 64.0 per cent. negative.

53 animals fed with tuberculous material from hogs: 53.0 per cent. positive, 47.0 per cent. negative.

2 animals fed with tuberculous material from rabbits: 50.0 per cent. positive, 50.0 per cent. negative.

2 animals fed with tuberculous material from monkeys: 100.0 per cent. positive.

5 animals fed with tuberculous material from hens: 100.0 per cent. positive.

Toussaint, Chouveau, Colin and others, all bear testimony that the continuous feeding of milk from a tuberculous cow to swine will cause the disease.

I have fed three hens with sputum from a man with tuberculous phthisis; one is already dead; cause, tuberculosis.

A rabbit that received two drops of the same under the skin, mixed with one hundred drops of freshly distilled water, died in six weeks, of tuberculosis.

Johne reports that a flock of ten hens, which were daily fed upon the crusts and leavings from meals of a man with tubercular consumption, died, one after another, of tuberculosis.

Zschokki relates of a cat that constantly accompanied and slept on the bed with a consumptive old maid, that died of tuberculosis.

German veterinarians have recorded many cases of tuberculosis extending over the cattle in a stable, from one or more diseased animals being among them, a few of which I will quote.

Albrecht tells of a farm on which were kept fourteen milch cows, a bull, and four young animals. Vacancies were always filled by new animals.

The latter were under his observation for three years, during which time tuberculosis was always present. He traced its origin to two old cows that had been there the whole time. New ones were healthy when bought.

He gives another case, where nineteen animals died of tuberculosis in a period of ten years. The disease was traced to a calf that came from a tuberculous cow. It was in the stable from 1864 to 1869, but did not thrive. In 1869 it was killed and found tuberculous. In the same year the other

cattle began to cough, and the disease gradually extended over all of them.

Putscher reports as follows: —

"Three large stables offered most favorable conditions for studying the question as to the extension of tuberculosis per contagium. In two of them the animals were kept for dairy purposes, as well as fattened for the market.

"In the others only steers for the latter purpose were kept. Fifty-four head were in this stable during three years. It is singular that this place should offer the most positive evidence as to the contagiousness of tuberculosis.

"In this stable were two oxen that had been purchased some eighteen months before the disease appeared. He examined them some time after purchase, and pronounced them tuberculous. As the two oxen did not fatten and become marketable, they were killed, and found to be decidedly tuberculous. As the other animals were sold, some fat, some not, every one was found to be tuberculous when slaughtered.

"New animals were bought to fill their places; their history and condition being subjected to a rigid examination before purchase.

"They were forcedly fed and soon fattened. One was very tuberculous in all organs; five had tubercles in the lungs; nine others were somewhat affected, and but five were found free from the disease.

"In the other two stables, thirteen animals were found to be tuberculous when killed."

Ollivier reports a very instructive experience in children that were from perfectly healthy parents, but lived and slept in a room with others, at an asylum, that were consumptive. The children acquired the disease and died. This testimony is sufficient to satisfy any reasonable mind, —

1. That constitutional weaknesses may be acquired, predisposing such individuals to tuberculosis.

2. That this tendency, as well as the disease itself, can be transmitted from parents to offspring.

3. That the milk or flesh from tuberculous animals can cause tuberculosis in other animals or persons, particularly babes, when fed upon it for a length of time.

4. That tuberculosis can be transmitted to healthy ani-

mals or persons, by their continually breathing air polluted by others having the disease.

These are the facts of observation and experiment. The real contagious principle is a bacillus discovered by Robert Koch in the sputum and tissues of persons dying of consumption, and in the tissues of animals, especially cattle. He isolated these bacteria, and cultivated them, in a pure form and artificial manner, entirely independent of the animal organism.

He carried these cultivations through many succeeding generations, and then inoculated animals with them and produced tuberculosis in them. He then again cultivated them from the tissues of these animals, and again produced tuberculosis in other animals, as well as by feeding still others with diseased portions from the first.

The description of these bacteria and how to discover them is decidedly a technical question and can well be passed over here.

Prevention.

We have come now to the consideration of the most important topic in connection with all disease.

If, in the following, I may make some remarks which appear to reflect upon the honor of our State, or upon individuals, I beg you to remember that I am not combating men, but evil principles, and am but endeavoring to fulfil the purpose of my life, to be a useful citizen of our country to the fullest extent my abilities will allow. In selecting bovine tuberculosis for a subject I had two purposes in view: —

First. To show you how much more important it is, beyond any other animal disease, to you as farmers and producers.

Second. That it shows, better than any other disease can, the true demands which the public have a right to make upon the veterinary profession.

I wish first to assert: That in the light of modern science, — in the light of what some European governments are doing, — neither the government of the United States, or that of any single State in this Union, not excepting our own

Massachusetts, are doing an iota to intelligently protect its people, or its vast animal interests, from disease.

Let us confine ourselves to Massachusetts. We have now, and have had, a "Cattle Commission."

What is that? A commission composed of two civilians, who, while they may know a great deal about the breeds and prices of all kinds of animals, know absolutely nothing about disease.

Then we have a Veterinarian upon it, who is only allowed five dollars a day and travelling expenses when actually employed. Gentlemen, I tell you boldly, that such pay as that, to a man of education, is a disgrace to the State which offers it, and an insult to the veterinary profession!

It may be enough for men who never received a technical education; men who may know a little more than an ordinary butcher; but it is not the proper remuneration for a man of ability who gives his time, or neglects his practice, for the public good, no matter how much public spirit he may have.

The day of pole-axe commissions is over. In times of dire necessity they may be valuable to stamp out a sudden outbreak of disease; but to prevent disease, to study into its nature, even the money spent on or by such a commission, in ordinary times, is worse than wasted.

Many of the Western States are appointing State Veterinarians at a salary of $2,500 per year.

Massachusetts must do as well. Yes, gentlemen; as I shall show you that, under ordinary circumstances, a $2,500 man is not good enough. We must have a man thoroughly acquainted with disease in man as well as animals; one thoroughly acquainted with the methods of research into the causes of disease, and instructed in the methods of veterinary education all over the world, so that he may be able to tell which of them have produced the best results, and be able to show how they can be improved upon in our own country; one intimately acquainted with the veterinary police laws and organizations of the world, so that he may finally give you the best. And lastly, and above all, gentlemen, we must have a man that knows all that has been done, and is capable of exploring still deeper into the rela-

tion of animal diseases to our own health and that of our wives and children.

A "Cattle Commission" is not competent for such a work. Weigh your "Cattle Commission" here in Massachusetts or any other State; your Boards of Health in this country; your Agricultural Bureau of Animal Industry, — in the balance against these possibilities which I tell you you have a right to demand of us veterinarians, and which I assert we veterinarians can and will yet fulfil for you, as well as the best of your medical men, if you will but give us a chance.

The graduated men of your State are a united body; every honest man among them is more in earnest in being anxious to serve the State in preventing disease than in increasing his practice. If Massachusetts or the United States cannot produce the man to start this work, then go to Germany and select the best man in their veterinary police organization.

The indications of the real work of the veterinary profession, as a part of the public service of the State, that I have given above, should show you that a "Cattle Commission" is not only a misnomer, but, as its name indicates, in no sense of the word suitable to your purposes.

While we do not want in the State a Bureau of Animal Industry, the Agricultural Department at Washington has started in the right direction by the employment of one veterinarian as the chief of its service.

Further than that the "Bureau" need not be copied. We can do better, and show them how work should be done, if you earnestly desire it.

In order to prevent disease in general, or even any given disease, it is necessary that we enter into the most minute study of every single thing that can possibly have the most remote connection with its genesis.

This purpose can be only expressed by the word research, — observational, statistical and experimental. To carry out this threefold purpose, it is necessary that some one authority, representing the accumulated intelligence of the people on the subject of public health and contagious animal diseases, should be selected by the State.

This authority should be the State Board of Health on the first part, and the State Board of Agriculture on the second. The true work of the first, or even the second, with regard to the prevention of disease in either man or animals, has scarcely dawned upon the minds of our people. Such boards are too often looked upon as honorary retreats in which to shelve useful, or useless, politicians.

The only qualification which should make any man a candidate for such a position must be fitness for the work.

Boards of health should be composed of an eminent jurist, the ablest hygienic special engineer obtainable, a competent chemist, a specialist on public health as a medical man, and the best qualified veterinarian to be obtained in matters of public health and contagious animal diseases.

The latter should be known as the State Veterinarian, and should also be connected with the State Board of Agriculture, which should constitute all the "Commission" necessary for the control of all questions in connection with animal diseases in the State.

As their duties require an expensive and special education, those of whom the State demands all their time and energy should receive $5,000 per year.

The Governor should be chairman of each board. It is absolutely necessary that he be intimately acquainted with their workings, wants and necessities, in order that he may intelligently recommend legislation.

The legislature should be more liberal to these branches of the public service than to any other department of government.

"Public health is public wealth." "Millions for defence, but not a cent for tribute." Yet we contribute comparatively nothing to save thousands of human lives and millions of dollars in animal property from the ravages of preventable diseases.

There is not a laboratory in the United States, fitted up as it should be, and liberally supplied with funds, under the control of competent experts, where researches are being made into the nature and cause of disease, or means of prevention sought for. There is not a medical school, far less a veterinary institute, in this country, where our youths can

get that technical and fundamental education through which alone they can become useful to the State in those professional duties which come under the head of State Medicine.

Yet, had we such laboratories, — and each State board of health must have one, — it is possible to discover a vaccine virus, in a pure form, that can be cultivated and dispensed in unlimited quantities, without having recourse to animals that may have the germs of tubercles in their blood; it is possible to produce a practical virus against the lung plague of cattle (which can be dispensed free of cost and be perfectly harmless), that has cost us so many millions and is likely to cost the country untold millions more; it is possible in this way to reduce the losses from hog cholera to a minimum. It has been begun in France, and we have men that can complete it here, if the State will only be true to its responsibilities to the people.

All these things are possible, and many more, of a kindred nature, probable. Scarcely a dollar is devoted to it, however. The State should be districted off into Public Health and Veterinary Police sections, — a county should form such, — each of which should have its chief medical and veterinary sanitary official, and the necessary number of sub-district officials from each profession.

All these men should be selected by the officials of the two boards mentioned, displayed competency being their only necessary qualification.

The two boards should alone constitute the examining and appointing bodies. Local authorities in cities, towns or districts, should be appointed by the respective boards and be subject to them, and not by, or to, the local governments.

All laws for these services must be especially drafted, according to the peculiar nature of each disease to be combated. They must be State, not local, laws or regulations, so that their execution may be uniform all over the State and incompetency and confliction avoided. Each local health or veterinary official should be paid for his services from the State funds. Local authorities, or communities, should hold the State boards responsible for the proper execution of these laws.

The practice of human and veterinary medicine must be

so regulated by the State, that the honest graduate may be protected in the exclusive right to the use of his honorably won title, and the people given a means by which they can distinguish such men from the non-graduated man or charlatan.

The right of selection as to whom they may employ should be left free to the people. Malfeasance in practice should be regulated by the State, and the further right to practice in the State prohibited to the perpetrator thereof, whether a regular or irregular practitioner in either branch of medicine.

All diseases should be scheduled, and all practitioners — medical, veterinary and irregular — should be obliged to notify the proper local medical or veterinary official of any and every suspicious case of disease, of either an infectious or contagious character, that was so ordained, under penalty of the law.

Statistics should be gathered, not only as to the number of deaths and their causes, but also as to the number of diseased persons, or animals diseased in any way; but especially as to everything having any causal connection therewith, even in the remotest degree.

This is especially true of infectious and contagious diseases, the least in importance of which is certainly not tuberculosis, whether in man or animals. Boards of Health and Boards of Agriculture should endeavor to educate the people in the principles of preventive medicine, as applicable to themselves or their animals, by the employment of competent lecturers from the medical and veterinary professions. The people would certainly meet them halfway in this regard. It is the duty of the State to guarantee to its people that the animal products which they use as food are free, not only from disease itself, but all disease-producing elements, as well as their water supply.

Our milk inspection is a semi-farce. If the cows are tuberculous or otherwise diseased, if they are improperly housed or fed, what a humbug it is to watch the stream from its fountain head to the consumer, and leave the spring itself — the cows — entirely out of consideration.

The State should know the exact hygienic condition of

every animal in it. By this means alone can we know how much our annual losses from such causes amount to, or to what extent contagious or infectious diseases prevail. We cannot know what we must seek to prevent, until we know what exists, how it comes to pass, and how it gets spread about.

The fact that the bacilli of tuberculosis have been found in the blood indicates that they must also be in the flesh; hence, no part of such animals, or derivatives from them, should be sold for human food.

Yet thousands of them are, and hundreds of quarts of milk from diseased cows are dispensed over our cities daily, especially to the poorer classes, or ignorantly consumed by the people themselves.

We should know the exact condition of every animal slaughtered for human food, both before and after death; we should know the condition of each organ; and, as shown by the Berlin abattoir, an exact statistic should be kept of the results of such examinations.

The State should compel the erection of public abattoirs in every city and town, and for every so many thousand inhabitants in country districts. They should never be the property of, or run in the interests of, joint-stock corporations, as at Boston. All animals destined for human consumption should be slaughtered therein, whether for the owners' use or not. These abattoirs should be under the immediate supervision of a chief veterinary inspector and the necessary number of veterinary sub-inspectors. These should be appointed by the State Board of Health but paid by the local authorities.

No animal fairs or markets should be held, unless under the supervision of a State veterinary official. This inspection should extend to the animals of all persons attending such gatherings.

I have endeavored to place fairly before you our true condition; to show you what you have a right to demand of the veterinary profession, and, above all, to indicate to you the only method by which success can be attained.

You, as citizens of the State, as the persons who have really the greatest interest in these matters, have the future in your hands.

(Mr. M. I. Wheeler of Great Barrington, in the chair.)

The Chairman. If there are any points in this very interesting paper that you wish further elucidated, you will please ask Secretary Russell.

Mr. Grinnell. I would like to ask the learned doctor how tuberculosis is to be discovered in its earliest stages?

Secretary Russell. It is generally accompanied by fever. I should diagnose it by the irritable condition of the system, — examine the animal's condition as to flesh, note the appearance of the hair, and, if I had increased suspicion, I should get a microscope and examine the milk. As Dr. Billings says, in this paper, where tuberculosis has affected the mammary glands it is readily discovered by a microscopic examination of the milk. Where there is a highly diseased condition, there would not seem to be any difficulty in finding out that the animal has tuberculosis.

Mr. Grinnell. I do not know how tuberculosis is to be discovered in its earlier stages. I have never had any experience with it, except that a neighbor in the adjoining town of Deerfield came over to see me some months ago, having lost a cow. He described the symptoms and said that a cow which was in a stall next to the dead one was also sick. He said he was very much afraid that it was pleuro. I did not see the animal, but he described the symptoms distinctly, so that I was entirely satisfied, and assured him that it was not pleuro-pneumonia; but I suspected that it was tuberculosis, and I advised him immediately to segregate the still living animal from the others of the herd. We have a very excellent veterinary surgeon in Greenfield. He was away at the time, but as soon as he returned I sent him over, and he examined the animal that died, and pronounced the disease tuberculosis. Undoubtedly the second one took it from breathing the air of the other. The second one was separated from the other cows, so that it did not go any further. I do not know how the disease can be discovered until the milk is dangerous to use. It is not so easily distinguishable, by any means, as pleuro.

Mr. Hartshorn of Worcester. I am very sorry that the gentleman who has written that paper is not here to answer

the questions which I think a great many here, who have not studied the matter so closely as he must have studied it in order to write that lecture, would like to ask. I think he could give us some very valuable information.

I have seen something of this disease during the last few years, and I think it is a subject to which the State Board may well turn their attention, to see if something cannot be done; perhaps not so elaborately as is suggested in the paper, but something that may be effectual in stopping the spread of the disease. I am confident there are many cattle in this State that are affected by it. I think, if there are any gentlemen in the hall who have sick cows in their own herds, and do not know what is the matter with them, if they would put them quietly out of the way, that would be the safe course. I know in a great many instances that is the best way to dispose of that kind of cattle. But a majority of sick cattle are not handled in that way. There was a man in my stable a few days ago who makes it his business to look through that part of the county and pick up stock which can be bought cheap. Anything that can be bought for six or eight dollars he is ready for. He figures on the price of the hide; and in talking over the matter with him, and questioning him somewhat, I found that by taking animals of this class, that were not well and could be bought very cheap, slaughtering them, wrapping them in the skin, and disposing of them immediately, he could handle them. That is a kind of business that we as farmers do not want to countenance. This man spoke of one animal he had killed within a short time, and said her lungs and liver were covered with tubercles, — spoiled entirely, — but the meat was all right! I venture to say that there is not a gentleman in this room but what would turn with disgust from the thought of eating a piece of meat from an animal diseased in that way; but that that is the way that this business is carried on, to a certain extent, throughout the State of Massachusetts, I think there is no doubt. I hope the State Board will take a stand at this time, and look into this matter in the near future.

Mr. Grinnell. Have you seen many cases of pronounced tuberculosis until they became very bad? My question was,

originally, how you could know, at an early stage, that a cow had tuberculosis? If a cow is in the condition the gentleman speaks of, certainly she should be put underground; but there must be an incipient stage, when we are using the products of that animal, and we do not know whether it has tuberculosis or not.

Mr. Cheever. Is not a hacking cough one of the earliest symptoms?

Mr. Grinnell. I think not, always.

Mr. Hartshorn. I think in many cases you would not discover any cough whatever. I have a paper in my possession that I read at a small meeting some five years ago, which I regret I have not with me, because that was written after consultation with a veterinary surgeon. In the early stages of the disease, you will have to watch the animal very closely to discover any symptoms of it. When you find an animal does not eat well, — that her hair is inclined to stand up and her ears to hang down, and there is a general depression, — you may well give close attention to that animal; but that is before the disease has advanced from its incipient stage. I think it is something which will linger in some animals for a good while to come. Two years ago I saw a cow slaughtered, — as fat a cow as ever I saw in my life: she certainly did not show any signs of the disease, — but her liver was covered with tubercles. A person without experience would not have supposed that anything was the matter with her. So I think that it stands us in hand, when we find a cow that seems sickly and feeble, to remove her from the herd, and consult somebody who knows something about it. I think the disease is transmitted, in many instances. I knew a cow in Worcester that a regular physician was called to see, — the physician of the family, — because the owner thought there was something the matter with the cow and did not want to use the milk for the children. The physician examined the animal and pronounced her all right. She continued to grow worse, and a veterinary surgeon was called in, who pronounced it a case of tuberculosis. The man did not believe it; the family physician had told him she was all right; and he kept the cow a little while longer, until he was satisfied that there was something the matter with her, when he

sold her. I was confidentially told where that cow went to, but I will only say that she went out of the State. A daughter of that cow appeared healthy, as far as any one could see; she had her first calf without trouble, but her second calf showed signs of the same disease that the old cow had, and the man was obliged to dispose of her. It would appear, therefore, that the disease is transmitted to the progeny. So I think we should do well to see that the males and females in our herds are healthy. I think it will be necessary at some time to have, as the gentleman suggests, a commission in our State to look after this matter.

Secretary Russell. If such an expert upon cows as the gentleman cannot distinguish the disease, that is an argument in favor of Dr. Billings' proposed system, that all cattle should be under the inspection of a competent veterinarian. It is not to be supposed that a thoroughly educated veterinarian would fail to discover tuberculosis in a herd even while it was in quite an incipient condition. I believe animals live long lives in a tuberculosed condition and communicate it to a line of progeny. That is one of the most dangerous things in the matter.

Mr. Varnum. I would like to inquire of Mr. Hartshorn, Mr. Russell, or any one who knows, if the disease is subject to treatment and cure?

Secretary Russell. I should say not, if you asked me.

Mr. Hartshorn. No, sir; I believe veterinary surgeons say that it cannot be cured. In its earliest stages they do not consider the milk or beef dangerous, but in its advanced stages they consider it very unsafe to use either. I think many of us do not know the condition of the liver and lights of many of the animals that are slaughtered at our slaughter-houses and come to market. I believe the Jews are very particular to know about the meat that they use.

Mr. Edson. I lived for some years in the city of Philadelphia, and I learned that the Jews would not eat a particle of meat unless it had been previously inspected by persons appointed for that purpose by themselves, who attend the slaughter-houses and put a red tag on the meat which is healthy; and the Jews will not buy any other meat. And a great many others, who are not Jews, will give more for

meat that has a red tag upon it. I have heard a butcher say that he has killed six cattle, only one of which would pass for Jews' use, — the Gentiles had to eat the other five. He said that there was not one animal in ten that came from Illinois that did not have a diseased liver; that not one in ten would pass amongst the Jews, and they had to take cattle from Pennsylvania to satisfy them.

Adjourned to evening.

Evening Session.

The evening session was opened at 7.30, Mr. S. B. Bird in the chair.

The Chairman. This evening we are to have a lecture from Prof. L. H. Bailey, Jr., of the Michigan Agricultural College, I have the pleasure of introducing Prof. Bailey.

THE GARDEN FENCE.

BY PROF. L. H. BAILEY, JR., OF THE MICHIGAN AGRICULTURAL COLLEGE.

Horticulture, the art, is old. It had its origin, with twin agriculture, in the fertile valleys of Asia while yet the world was new. Man early learned to till the soil. He was a farmer. The earth gave him her fruitage. He selected and improved it. Generation after generation the slow increment of progress accumulated. The fruits of the first garden gave place to others. Gradually the old were lost, and the best were scattered to the four quarters of the globe with the early migrations of men. The history of many of our cultivated plants is almost a history of the human race. But with the gift of fruits, God sent other friends, disguised. Weeds originated when cultivation originated. There are no weeds where there is no cultivation. They are enforcers of duty. They early punished neglect with the consuming growth of tares. They have always been coercers of improvement. It is singular that we do not recognize this fact. Even Virgil was alert to it: —

"The father of humankind himself ordains
The husbandman should tread no path of flowers,
But waken the earth with sleepless pains.
So pricketh he these indolent hearts of ours,
Lest his realms be in hopeless torpor held.
* * * All these things he did
That man himself, by pondering, might divine
All mysteries, and in due time conceive
The varying arts whereby we have leave to live."

Surely ours is a goodly heritage. Until our time has man improved upon nature, till the first parents of cultivated plants are lost, and we are bewildered with endless variety. If we cannot discover the devious path by which every fruit has come through the centuries, gathering here and there an element of that mysterious something which better fits it for the use of man, we can, nevertheless, enjoy an heritage which surpasses the hanging wonders of Babylon or the fabled gardens of the Hesperides. Perhaps we are approaching the limits of this development. Certainly our methods of cultivating are not essentially different from those which find record in Columella or in the verse of Virgil, methods which in essence were old when those authors wrote. The ancient art appears to have taken on a fixedness which is indicative of staid old age. We plough and sow and reap as did our fathers. If we reap more than they, it is chiefly because we have improved a little more in the line of their improvement. Surely here is not a field for the impetuous Yankee, who would conquer countries of which his father had never heard, who is irrepressible in any enterprise which promises profit, and demands business, brass and brains.

In 1795 a short and unpretentious article on grafting appeared in the Philosophical Transactions of England. The writer had observed that in England the most disastrous of the diseases of the apple and pear was the canker, — a browning and dying of the younger shoots. It was the common opinion among orchardists that this disease is caused by a deterioration of the variety; the older varieties were running out. The writer opposed this view, and assumed that the disease had been conveyed, in each particular instance, by unhealthy scions. He conducted a series of

experiments. He procured healthy young stocks, and grafted upon them the brightest and thriftiest scions he could secure from the cankered trees. When these had grown, he inserted the best scions which they afforded on other fresh seedling stocks. This progressive operation was repeated for six generations. Although he did not escape the canker, he found that he had hit upon a fertile trail. He satisfied himself that scions from old and worn-out trees are prematurely productive and short-lived, and reasoning from this he concluded that scions from very young seedlings would prove to be tardily productive and long-lived. Numerous experiments appeared to prove the proposition. Scions maintain their essential characters when set upon other stocks, or at least the characters of growth and fruitfulness. The graft will probably not endure long after the natural expiration of the tree from which the scion was taken. Probably most of the ancient varieties of apples had been propagated from scions from old and feeble trees, and, as a consequence, most of these fruits known to Parkinson and Evelyn had become extinct. The direct and impartial statements, the scientific methods, and the novelty of the subjects treated, at once brought the paper and its author into prominent notice.

Four years later our author appears again. Again he is a pioneer. The canker in apple and pear trees still demands his attention. He had observed that in the animal world in-breeding produces disastrous results. May there not be something akin to this in the vegetable kingdom? He proposed to cross-fertilize one variety of apple with another, hoping from the seeds of the cross to secure new and healthy varieties. Impatient for results in a field entirely new, he began experiments with pease also. The progeny of the crosses were new and peculiar, and the details of the experiments are still full of absorbing interest. At this time the whole manner and method, the whole physiology of the phenomena of pollination and fecundation were unknown. Numerous doubts arose in the mind of the experimenter. He endeavored to ascertain if one seed could be the product of two males, if the quantity of pollen used exerted a varying influence, if the male or the female parent is the most

potent, if successive crosses would still change the offspring, if the characters originating from crossing can be discharged by subsequent culture. He experimented with apples, pease, wheat, grapes, and other plants. We who are familiar with the magnificent science which has to do with the crossing of plants, which first took definite shape and direction under the genius of Darwin, and which in its phenomena and influence is boundless, are fully prepared to admire those men who first caught a glimpse of this wonderful plan of nature. We look with a species of reverence upon Conrad Sprengel who in 1787 began to study in the fields the mutual relations of flowers and insects, and who became impressed with the idea that all parts of the flower subserve some definite economy; that "the wise Author of nature would not have created even a hair in vain." But in this same year 1787 a greater man than Sprengel began his work upon the same subject. The German and the Englishman, unknown to each other, caught the thread of nature's purpose and began to unravel her close-woven fabric. The one interrogated nature in the field, the other courted her in the garden. Our author, the Englishman, was impatient to apply to the common uses of life the discoveries he had made, although he recognized, perhaps as fully as the other, their importance to the preservation of species in wild nature. He saw, too, the relation of the insect to the flower. "Nature seems to have wished that no flower should be fertilized by its own pollen," said Sprengel, — a statement which has become celebrated. "Nature intended that a sexual intercourse should take place between neighboring plants of the same species," said our author, — a statement truer than the other. "Nature abhors perpetual self-fertilization," said Darwin. Our experimenter gives a pleasant account of the agencies of insects in cross-fertilizing plants. But after all he saw more clearly the relations of the phenomena of crossing to the much-loved plants of his garden, and ventured the assertion that "by this process it is evident that any number of new varieties may be obtained; and it is highly probable that many of these will be found better calculated to correct the defects of different soils and situations than any we have at present; for I imagine that all we now possess have in a

great measure been the produce of accident; and it will rarely happen, in this or any other case, that accident has done all that art will be found able to accomplish."

Among the flowers of his garden, our author became convinced that all the parts of the flower, — the showy petals, the stamens and the pistils, — are but modified leaves. Although he was not the first to conceive these ideas, he nevertheless arrived at his conclusions independently, for the studies of Wolff and the poet Goethe were then unknown in England. Upon this apparently singular assumption rests much of the important investigation of to-day. He studied the motion of sap in trees, and made numerous experiments, some of which proved that the ascent of sap does not take place between the bark and the wood, but through the wood itself. In 1811 he gave to the world the now familiar method of root-grafting, with which he had experimented upon the pear, apple, plum and peach. A year later he published a minute and interesting account of the movements of tendrils, a subject now made classic by the work of Darwin. About the same time he introduced a peach which he produced from an almond. In the same scientific and quiet spirit he discussed the causes which influence the direction of roots, the nature and extent of expansion and contraction in the trunks of trees occasioned by heat and cold, the parts of trees first impaired by old age, and a long line of vital subjects, always with well-directed experiments. In many cases he came near anticipating some of the beautiful generalizations which we now know as Darwinian.

But what is the significance of this work, and who is its author? Horticulture has became a science, and Thomas Andrew Knight is its founder! Science has climbed the garden fence. It is not enough that we plough and sow and reap as did our fathers. Unto us are given countries to conquer of which they had never heard. Here is work for the impetuous Yankee; work which is as boundless as time and energy. Horticulture, the art, is old; horticulture, the science, is new. To get our science from the field and the laboratory into the garden, is the problem of the age. We must demand it there. Therefore, I propose to speak to

you about the Garden Fence, or what we don't know about horticulture.

The fence which stands between theory and practice is relative. It exists and it does not exist. It depends upon the position of the observer, or rather upon his definition of the word practice. This word practice is much abused. To one all knowledge is practical: it is a part of a grand scheme of progression, and, sooner or later, it exerts an influence upon some one or more of the varied industries which support the life of man. This is a philanthropic view of learning. It recognizes the important fact that all knowledge is practical, because it adds to the weal of mankind. Money is not always the true measure of the practical, else what is practical to the recipient is impractical to the giver. A person looked through a scientist's microscope; he saw the peculiar objects which were explained as the parts of a fungus, but he saw no application of the knowledge he had gained. "What's it good for; what's the use of all this study?" he asked with disgust. "It gets me a living, sir," retorted the scientist. We must not measure knowledge by its immediate effects, any more than we should measure an apple tree by the young seedling. But he who invariably measures the influence of education and knowledge by money, is a niggard, and is opposed to advancement. It is time we did something for the fun of it. If we are to make science conducive to the needs of man, we must search all science, for we know not where some treasure is hidden. The horticulturist will quite as often find some useful hint in an inconspicuous weed by the roadside as in the cultivated products of the garden. It was by experimenting with a frog that Galvani discovered galvanism. That frog lives in every industry which brightens our civilization. It was a wild geranium which gave Sprengel the hint of that wonderful kinship which exists between the insect and the flower; and that wild plant of the fields will always linger in the traditions of our science and our horticulture.

One can never become a successful investigator in any subject if his whole skill and education are confined to that subject. Much of our experimenting is entirely worthless, because the experimenter is not able to grasp the relations

which exist between his subject and other subjects akin to it. And herein lies the greatest gulf between theory and practice. Says an experimenter, Prof. W. R. Lazenby: "Nothing that is really good or true in theory can ever fail in practice. If failure occurs, it proves that the theory is false or the practice incomplete." It is singular how loudly many men decry the opinions of scientists as vague and impractical theories, while they themselves are bristling with whims and notions that would do justice to the absurdities of the Middle Ages. If a thousand devils can dance on the point of a needle, how many stalks of chess will grow from one grain of wheat?

But after all there is a conspicuous fence about the garden. The botanist searches for plants in woods and glades and fields; he studies them; he chases them to the garden fence and stops! When a raspberry gets into the garden it is without the pale of the true science of botany! "Our roses have ceased to be a botanical study," said a great botanist, when in fact they have never been worthy so close a study as now, when they have run into all the forms of our gardens; when they have so far disguised themselves as to make their very origins matters of speculation. Why have they varied, how have they varied, how much can they vary, what is their relation to soil, to light, to heat, to moisture, to pollination from other varieties or species; in short, what does botany tell us of the rose under cultivation? Nothing. We don't know the meaning of a rose; if we did, who knows but that we should find a key to many of the secrets of the vegetable world? The botanist throws it aside because it has lost its permanent specific characters; he cannot name and classify the perplexing multitude of forms. But the very fact that the plant is so perplexingly variable is all the more reason why the botanist should aid us in its study. Said Darwin: "One new variety raised by man will be a more important and interesting subject for study, than one more species added to the infinitude of already recorded species."

We must get below the surface indications. We need to know the principles which underlie our experiments before we experiment, or else we must experiment for the purpose of discovering the principles. Experiment is rife to-day;

the empirical spirit of the age is contagious. Every one experiments or investigates. The greater part of this experiment is the reflex — the echo – from the scientific tendency of the times. It commonly has little scientific basis and no permanent value. People are experimenting to find out what they ought to know without experimenting. Every experimenter must know what experimenting has been done already. He must be an educated man. Experiments are often interpreted incorrectly; they are said to teach what they do not teach. A person sows land-plaster on one-half his wheatfield and leaves the other half unfertilized. Upon the plastered portion the wheat is four or five inches higher than on the other. Therefore, says Quizicus, plaster produces a great increase of wheat; not thinking, however, that growth of straw is one thing and yield of wheat another. A gardener had two rows of onions. Upon one he applied guano, upon the other bonedust. One yielded four bushels more than the other, and he attributed the larger yield to the fertilizer; but under the same treatment they would, undoubtedly, have varied as much. An observing fruit-grower possessed a plant of smooth-fruited gooseberries. A favorite family cat, having unceremoniously died, was buried underneath the bush, and behold! the next year the bush bore hairy berries, and has so continued to do until the present day! Most of my neighbors keep seed corn by stripping the husks and braiding them together and then hanging the ears in a dry loft; but one, more acute than the rest, one year hung his corn in a hoghouse, by way of experiment. The next year his corn failed to grow; therefore, said he, corn hung in a hoghouse will not grow. This is akin to the valuable experience of a certain Irishman, to whom rhubarb was given in a case of sickness. He recovered. Shortly after, his neighbor, a Dutchman, fell sick, and Pat administered the rhubarb. The man died. Pat hastened home to write on the fly-leaf of his Bible: "Medicine which will cure an Irishman will kill a Dutchman." Surely, experiment is in the wind. Even the city editor has caught the contagion, and writes: "I am building up an article on potato rot. What insect causes it? How does the rot get in its work? Is it more prevalent when cholera is raging?"

Of a surety, we need our botany and chemistry and zoölogy and meteorology in the garden. We need intelligent investigation. Moreover, we need extensive and extended investigation. If we need one thing more than another, it is that the botanist shall climb the garden fence and include within the realm of his science all the plants which we till. Even Knight made this demand, nearly a century ago: "I cannot dismiss this subject without expressing my regret that those who have made the science of botany their study, should have considered the improvement of those vegetables which, in their cultivated state, afford the largest portion of subsistence to mankind and other animals as little connected with the object of their pursuit. Hence it has happened that, while much attention has been paid to the improvement of every species of useful animal, the most valuable esculent plants have been almost wholly neglected. But when the extent of the benefit which would arise to the agriculture of the country, from the possession of varieties of plants which, with the same extent of soil and labor, would afford even a small increase of produce, is considered, this subject appears of no inconsiderable importance. The improvement of animals is attended with much expense, and the improved kinds necessarily extend themselves slowly; but a single bushel of improved wheat or pease may, in ten years, be made to afford seed enough to supply the whole island, and a single apple or other fruit tree may, within the same time, be extended to every garden in it."

There are a few who have surmounted this garden fence at some of its highest points, and of these, none stand out so clearly as Charles Darwin, the grandest horticulturist of any generation, — the man whose work pervades all scientific thought to-day. It is not the man who tills the soil who is necessarily the best horticulturist; it is, rather, he who knows nature best, and who can put his knowledge into form for others to use. A Darwin, although he never held a hoe, can do more for the permanent and profitable advancement of horticulture than all the horticulturists of New England. Out of this great wave of unscientific experiment which floods our land, we shall one day expect another

Darwin to rise, who shall reveal to us more of the methods of nature than we can dream of to-day.

The art, the handicraft, of horticulture is well understood; but every part of it which touches a science demands further investigation. We do not know the scientific principles which underlie these handicrafts.

Of the subjects of science which have been worked out, I know of none so thoroughly done as pear-blight. Indeed, the researches of Burrill and Arthur, during the last five years, may be taken as the type of successful investigation regarding the diseases of plants. We hear much, nowadays, about parasitic fungi and their action upon the plants of our garden, and in many cases we can apply efficient remedies or preventives. We are inclined to regard the whole subject as one well understood, while, in fact, very few are so imperfectly understood. We have not yet been able to describe, to become acquainted with, the outward appearances of many of these fungi, and in comparatively few cases do we know the whole intricate round of life of the species. But we must soon begin to learn another set of facts; we must discover the relations which exist between the nature of the lost plant and the aggressive fungus. Why is it that the red-rust always attacks the Kittatinny blackberry, while some other sorts are exempt? Why does the bean-pod fungus attack the white wax variety in preference to others? We say that one variety has a thicker epidermis than another; that it is a more vigorous grower, and is therefore enabled to resist the attacks of the fungus; but these notions are indefinite. The fact is, we don't know why one variety resists a fungus and another does not. If we did, one of the problems of our horticulture at present would be the breeding up of fungus-proof plants upon scientific principles. If there is any attempt in this direction at present, it is entirely haphazard. Not many years since, the notion was entertained by many scientific men that the peculiar objects which we know as parasitic fungi were not distinct organisms, but simply modified cells of the diseased plant. We have now outgrown this notion; but we are, nevertheless, far short of solving the mysterious relations which exist between the fungus and the plant upon which it grows. We

have emerged from one difficulty but to encounter another. The things which we do not know about horticultural science are astounding in number and importance, and they pertain to the commonest operations of the garden as well as to the most difficult and extraordinary. Let us examine, for instance, the simple matter of grafting and budding, which, so far as the art is concerned, is as well understood as tillage itself. It was practised by the Romans. We bud our fruits as they did, but we know little more than they concerning the principles of the operations. What do we know of the laws of affinity between plants,—laws which enable us to determine the limits of grafting? Some pears thrive upon the quince, some do not; but the quince does not thrive upon the pear. The pear is short-lived and unsatisfactory when grafted upon the apple, which is very near it in botanical kinship; but it does just as well, it is said, upon the thorn, which represents a distinct genus. The peach takes poorly on the apricot, but it and the apricot thrive on the almond and the plum. Most plums do well upon peach roots, but the Canada Egg commonly fails to unite, and the Lombard makes such an imperfect union that it soon breaks off; still, between these plums and others, we can discover no differences to account for these peculiar behaviors. Sweet cherries do well on the Mahaleb cherry, but the Mahaleb will not succeed on the sweet cherries. The gooseberry will not grow on the edible currants, but it thrives well on the wild buffalo currant of our West. A certain Chinese orange almost fails to bear upon its own roots, although it becomes very prolific when grafted on one of the lemons, a distinct genus. We know scarcely anything of the influence of stock upon graft, and we are unable to discriminate, in most of the recorded facts concerning the matter, as to whether some change in the scion is produced by the stock upon which it grows, or by soil, climate or culture. Still, the subject is one of immense practical importance. We may have a tree with plum roots and almond leaves, and the trunk may be composed of both peach and apricot, but we have no knowledge of the physiological relations which exist between the parts of this composite individual. We have a few facts concerning some indefinite influence which the

scion exerts upon the stock. An experienced nurseryman habitually looks ahead, when he is digging trees, to note the character of the tops of the trees he is about to dig, knowing that a very upright grower will have a tap root, and a very bushy grower a spreading root. But the top is the scion and the root is the stock: how is it possible that the scion can influence the root upon which it grows? Many shrewd nurserymen tell us that if we graft a plum upon the young root of a peach, in a few years the peach root will change to a plum root, the identical fibres which were once peach become essentially plum in their external features. Variegation has long been noticed to be an occasional influence of scion on stock. A stock with ordinary green leaves is sometimes forced to produce variegated leaves by inserting a bud from a variegated variety; and this is all the more singular from the fact that the buds themselves often fail to grow. The stock may be influenced in this wonderful manner below the insertion of the bud as well as above it. If we attempt to explain this mystery we but unlock other mysteries. What is variegation? What causes it? Some contend that it is a contagious disease, and that budding is an inoculation. I find that, so long ago as 1727, this idea was advanced; for Prof. Bradley of the University of Cambridge in England observed, "that the distemper which shows itself in the yellow and white variegations of the leaves of the common white jessamine, and several other plants, may be communicated to every plant of the same tribe, by inoculating only a single bud of the variegated kind into the others which have plain green leaves; and, though the bud does not live, yet barely by the application of it to the healthful tree, we shall find the yellow blotches or variegations of the unhealthful bud communicated to every part of the healthful plant. Just as it happens when a man has had the small-pox inoculated upon him, his whole mass of blood will become infected with the poison." We are little wiser upon this point than Bradley was. Now there is on record a case in which an entirely distinct plant, once regarded as a true natural species, was produced by grafting a scion of one species upon a stock of another. A hybrid was produced by grafting. Did we know how and why this

came about, might we not apply the principle indefinitely? Now we have the remarkable statement that a certain Italian, through long study and experience, has hit upon a device by which he can produce new varieties of roses by the simple art of budding. Whether or no this statement be true, it is, nevertheless, a straw which indicates a current. The more we study this apparently simple matter of budding and grafting, the deeper we are surrounded by an impenetrable maze of mystery; we are everywhere limited by the unknown, — unknown. I am not to be understood as saying that we have made no advancement in grafting. Columella declared that he could grow several kinds of grapes in a single cluster, by tying together cuttings from four or five varieties, enclosing them tightly in an earthen tube, and burying them in the soil to grow together. In this manner he said that a compound vine could be produced, which would bear many-fruited clusters. He would produce seedless grapes by splitting his cuttings, removing the pith, and then placing them together again! He also detailed a device by which "scions of all kinds may be grafted upon all sorts of trees whatsoever." The Romans evidently had little notion of the affinity of species. Virgil would produce a curious medley:

"But thou shalt lend
Grafts of rude arbute unto the walnut tree,
Shalt bid the unfruitful plane sound apples bear,
Chestnuts the beech, the ash blow white with the pear,
And under the elm the sow on acorns fare."

We should expect that the horticulturists of to-day should not hold such notions as these; verily, there has been advancement, but for the most part it has been a stumbling advancement. Our Pegasus is blind.

Let us return to the botanist. Our curiosity is excited as we see him strolling critically over the fields, collecting-case in one hand, botany in the other. How does his botany help him in his rambles? Is it possible that he can identify all the multitude of forms of vegetation with names and descriptions? He can; and herein lies one of the wonders of botanical science. The classification and the method of

naming are such that the diligent botanist can hold in his mind the names and the kinships of thousands of plants with no tax upon the memory. There is no system of arrangement so complete, no logical method of subordinating a lesser character to a greater so thorough, as the systems of classification and nomenclature which we apply to wild plants and animals. On the other hand, there is no system more bungling, none more thoroughly haphazard, than that which we apply to the plants of the garden. Is there not some way to get our classification and nomenclature over the garden fence? If the subject is beset with difficulty, so much the more do we need system, and so much greater will be his honor who constructs it. I hope to see the day when the gardener can botanize intelligently in his garden; I hope to see a handbook which will aid us in the determination of garden varieties. And this, you must admit, would be an exceedingly "practical" sort of a volume. It would endeavor to give us the synonymy of each variety; it would tell us, before we make our spring order for seeds, whether the Leyden White Summer, the Satisfaction Black-seeded, the Black-seeded Yellow, the Fine Imperial Cabbage and the Berlin lettuces are in fact distinct varieties or whether they are all names for one and the same thing. This is an exceedingly important matter, to find out if many of our common varieties are really distinct, and to hunt out the oldest name for a permanent appellation. It must be investigated with great care, and upon a scale not profitable for the individual gardener, who must live by the sweat of his brow. It must be investigated by persons who have trained eyes. In this direction the New York Agricultural Experiment Station is a pioneer in this country, so far as I know. Each year the Station garden grows some one vegetable in all its varieties, for experimental purposes. In the Station report for 1883, 58 varieties of beans are accurately described and compared. Progressive horticulture demands that some efficient system of classification be worked out for each of our orchard and garden plants. It is by no means a satisfaction, if we wish to find the name of some apple new to us, to be obliged to know the name before we can find the name in an alphabetical arrangement.

We must learn the possibilities of native wild plants. It is in this direction that we must look, in many cases, for increased hardiness and productiveness. Our Wild Goose and Miner plums indicate a new field for advancement in plum culture. Our wild black currant and dwarf sand cherry are awaiting investigation. We must breed the bitter lining out of the pecan and the big seeds from the papaw. We often account it a fortunate circumstance that the cradle of the human race was rocked in southwestern Asia, the home of fruits, the land which flowed with milk and honey. But if the Garden of Eden had been in America, our heritage would have been as great, perhaps greater. The possibilities of our wild fruits as a whole are great. Already our gardens are planted with native grapes, native strawberries, native raspberries, native blackberries and native cranberries. The native species are by no means all utilized. A fertile field of future experiment will be the growing of edible fungi. Many wild species are agreeable and wholesome, but so far we have succeeded in cultivating but one, the world over.

Gardeners are familiar with "sports," those occasional mysterious plant forms whose advents are unknown until they suddenly appear. The phenomenon itself of sporting is known of late, since the work of Darwin, as bud variation, a term of great importance to the gardener, as malaria is to the doctor, since it covers volumes of ignorance. Cherry trees which habitually bear red fruit sometimes produce a branch which bears white fruit. Yellow plums have been seen on certain branches of a purple-fruited tree. Greening trees sometimes produce russet apples, and russet trees sometimes produce greenings. Potatoes are sometimes half white and half purple, and planting one side or other of the tuber will often reproduce the peculiarity of that side. Weeping branches appear on trees of upright growth. Variegated or curiously cut leaves appear suddenly on many plants. Plants so unlike all others as to be called distinct species have originated by bud variation. In this manner the moss-rose probably originated, and certainly the nectarine is a sport from the peach. We know nothing of the causes of bud variation. We shall expect to some day

discover many and diverse causes for these fitful phenomena. Did we know these causes now, we might apply them to the production of better fruits. Sport is certainly a relative term. It is a sport to-day, because we do not understand it; to some horticulturist of the future it will be but the operation of a law.

We sow with the confidence that like produces like, that as we sow so shall we reap; but the keen observer sees in the offspring of almost any seed, when sown in considerable quantity, a wide variation. Indeed, no two individuals are alike, although they spring from seeds grown in the same fruit. Plants have individual characters just as clearly pronounced as do people, and so imperceptibly do these characters widen in all directions that we cannot say when any character ceases to be individual and becomes varietal; that is, common to a number of individuals; or even when it becomes specific or permanently common to a class. Thus it happens that characters which are in the judgment of one man varietal are in the judgment of another specific, or may be even individual. "Species are judgments," said a great botanist; and, necessarily, he who has the best judgment and the most experience is the best judge of character in plants. Such judgment is of supreme importance if one would enter the higher fields of modern horticultural research. Often the seeds from the same pod will produce plants very different in their characters; the seeds "break," as the gardener phrases it, and we get what we call new varieties. Why? We say that it is due to peculiarities of soil, of culture, of climate, of some previous influence of pollen, or something. Surely it is due to something; so far we are correct. Reasoning from this known tendency of plants to vary, people often construct curious notions, which lie entirely without the limits of possibility. These limits are readily distinguished by the botanist, but cannot always be detected by others. Here we find an explanation of those antagonistic notions which have been a feud between the farmer and the botanist; the notion on one side that wheat turns into chess, and on the other side that the supposition is absurd. It is curious to what extent this ideal transmutation of species is often carried. As early as 1747 a Latin dissertation, written under the direction of

the learned Linnæus, was published in Europe, to disprove the fallacy that wheat turns to chess. The notion has even an older history than this. The idea that certain grasses regularly transform into each other is as old as recorded history. It is said that in early times the peasantry of Europe had discovered a regular series of transformations, due to poor soil, from wheat to rye, then to barley, then to darnel grass, then to chess, and finally to oats! And it was also declared that the reverse conditions of a fertile soil would evolve wheat from oats through the same intermediate plants! At the present day, and in portions of our own country, chess and clover degenerate into timothy, and horse-hairs grow into snakes! And the people who observe these unorthodox pranks of nature are often among the first to scorn the idea of evolution, which attempts to account for the instability of species in a scientific manner.

We secure new varieties of plants largely by random. This method is unscientific, and, to the student of natural science, is unattractive. We do not know the possibilities which lie in a seed. Sometimes seeds contain two embryos, two initial plantlets. It was once observed that two per cent. of a lot of young osage orange seedlings were united twins: the seeds had contained two embryos or germs, and the young plantlets had grafted themselves together. A still more remarkable case is that in which two very dissimilar plants were obtained from one seed of a fuchsia, the double-embryo seed, in this case, being the product of cross-pollination. We do not understand the mysterious effects of soils upon young seedlings. Prof. Tracy of Michigan sowed pease of one variety in a row which extended from poor soil to rich soil. Upon the rich soil he obtained a new variety of pea which reproduced itself from seed. We say that strong soil was the cause; but the same thing would probably not occur again in many years, under conditions which, so far as we could judge, are exactly similar. We do not know why some varieties or species of plants are more variable than others. Some cultured varieties will reproduce themselves with remarkable permanency from seeds, others will not. These fixed varieties, those which come "true to seed," we designate as something more than varieties; they

are races. We have a name for them, as indeed we do for most of the phenomena of nature; and I often think that there is a tendency to crawl under these technical names, and to applaud ourselves with the idea that we have picked the meat out of nature's puzzle. Seeds from young plants appear to produce a better and more variable offspring than those from old plants of the same species. Dr. Van Mons of Belgium, inspired by this fact, built for himself a permanent name in the science of horticulture. He selected seeds from the first fruits of young trees, especially from young trees of new varieties, and planted them. From the first desirable fruits of the seedlings obtained, he again selected seeds and planted, and so continued to do for several generations. Each succeeding generation fruited sooner than the preceding ones and produced better fruit, until about the fifth generation, beyond which there was no increase. The fifth generation of pears bore at three years from the seed. Van Mons proved that by selecting seeds from these young plants, which are in "a state of variation," whose characters are not yet fixed by age, we shall rear the best seedlings. And here another question arises. If the characters of young trees are not yet fixed, will the first fruits be the same as those which the tree will bear in maturer years? Are the habits of the boy the same as those of the man into which he grows? We know that in many cases they are not. But here we find a fact that we should not expect from the conclusions of Van Mons; the first fruits of the tree, if they vary at all, are commonly inferior to the later fruits. Still these same inferior fruits give a superior progeny! Would it be possible by root-grafting scions from a seedling at different times during the first four or five years of its existence to secure different varieties of fruit? We shall try it.

Verily, we do not know the possibilities of a seed. We need well directed, extended experiment. We need to plant very many seeds of every useful plant, under conditions as nearly alike and as much unlike as possible, and to make a numerical record of the peculiarities of variation. Do they vary most constantly in this direction or that? We may then be able to discover some law of variation.

In a general way, we have hints as to some causes of vari-

ation; but here, as elsewhere, we are obliged to cover our ignorance by a technical term. Certain conditions of vegetation attend certain climates, and we habitually refer those conditions to climate as a cause. This disposition by no means discloses a specific cause, however. Climate is ambiguous. In common usage it includes latitude, heat, moisture, drouth, winds, intensity of sun's rays, electrical conditions of the atmosphere, and other phenomena. We must analyze climate, and study the effects of its component parts. Here is a field which is wonderfully fascinating, from the fact that it deals with problems of such magnificent proportions; it includes at once, within its scope, the whole world, with all its depressions and elevations, its currents and counter-currents, its land and its waters, its winds and its calms. It traverses every unknown country, under the lead of versatile Von Humboldt, the father of botanical geography; it visits the islands of the sea and climbs the awful ranges of the Andes and the Himalayas. On the other hand, it recognizes every local distribution of heat and cold. We are becoming familiar with some of the results of a change in latitude and climate, but we can scarcely frame laws. When a vegetable is taken North it usually becomes dwarfed. The average height of Indian corn in the Gulf States is twelve feet; in Canada, six feet. Compare our Yankee corns with the Southern dent. Many woody perennials of the South become herbaceous annuals at the North; castor beans and cayenne peppers are examples. The apples of northern Russia grow on bushes, rather than trees, which are planted in hills after the manner of corn. Aside from dwarfing, plants usually take on different forms as they are taken northward. The tops are lower and rounder. In lower latitudes they incline toward a pyramidal or fastigiate shape. The lower branches of conifers are proportionally longer in Canada than in Carolina. There is evidently a greater tendency at the North for plants to sucker and to produce underground stems. Although northern latitudes induce dwarfing, the amount of leaf surface is proportionally larger than southward. As checking growth induces fruitfulness, we can readily understand that plants are commonly more productive northward, so long as the climate does not

interfere with the health and maturity of the plant. As a rule, however, it appears that the fruit of any species increases in size as we go south, but the number of fruits to a given extent of plant surface is greater northward. A recent census gave the average yield of wheat per acre, as 14.2 bushels in the upper ten Atlantic States, and 9.8 in the Gulf States, and 30 66 bushels of oats against 14.2 bushels. The latitude of the greatest productiveness of any plant is usually north of the latitude of greatest growth; *e. g.*, if a plant reached its greatest size at 40°, its greatest productiveness might be at 45° or 50°. If dwarfing produces fruitfulness, without producing serious concomitant evils, it is desirable; for while we may lessen the actual amount of production on each plant, we can grow many more plants to the acre. The increase in plants can be much greater than the decrease in individual production, but there must be a limit to profitable dwarfing. The most productive ratio of size of plant to the amount of fruit it bears, is an important and entirely unsolved problem. It has been stated that in England the most profitable ratio for wheat is about ten parts of straw, by weight, to seven parts of grain. Given, the profitable ratio and that latitude where this ratio will be naturally developed, and we have the essentials of a great advance in intensive horticulture. Seeds could be distributed from the given station; and even if we were not able to produce distinct varieties, which should possess this ratio as a permanent character, the seeds could be frequently distributed. We are gradually approaching this climax. Northern-grown seeds are now in great demand. This fresh stock, this change of seed, is of great importance in many respects, of which the feature I have detailed is perhaps the most important, though the least understood and most neglected. By selecting seeds from a certain locality we are enabled, with a great degree of accuracy, to secure the salient features of the plant in that locality. "The enhancing of any peculiar feature of growth may be done by bringing seed from a climate which has that tendency." Latitude, or some of the conditions of climate which accompany latitude, has a potent influence upon color. Northern fruits, like northern maidens, have ruddy cheeks. In old Russian song

is a marvellous maiden, whose neck was like a swan, whose lips were like cherries, and whose cheeks were as red as the Volga apples. The object and the figure are attractive. The beauty of Alpine flowers is proverbial. On the unfrequented slopes of high mountains, fringing the perpetual snows, are the prettiest flowers the world affords. In vain do we search for the cause. It is pleasant to entertain the proposition of Wallace, that these bright Alpine colors are unusually gaudy advertisements to insects, which are rare upon high mountains. The reciprocal relations of flowers and insects are always absorbing; but although the fact that Alpine flowers produce unusual quantities of nectar appears to uphold Wallace's hypothesis, we must nevertheless forego the pleasure of its entertainment. We find the same gaudy colors where insects are common; moreover, we can produce them, in short periods, by a transfer of culture. Perhaps we are beginning to solve the problem, in the recent studies of the intensity of sunlight at high altitudes and latitudes. As we learn more upon this subject, we shall undoubtedly be able to control to a great extent the colors of our flowers. Indeed, Flahault had fourteen species of ornamental plants sown the same year in Paris and in Sweden, and of these, thirteen produced much brighter flowers in Sweden. The study of the intensity of sunlight will probably enlighten us upon the causes of high flavor in northern products, for be it known that high latitudes increase flavor in fruits; I am not able to verify here my above comparison in regard to maidens. We must know why it is that our apples and corn and vegetables are better at the North. It is lately asserted that even the watermelon, when well grown and thoroughly matured, is probably better at the North than at the South. If the world will still persist in accusing Brother Jonathan of trickery, it must, nevertheless, give him credit for honest, concentrated fruits. Hot climates develop poisons and aromas. Aromatic plants are characteristic of deserts, the world over, says Wallace. I have in mind a pleasant incident of opening a bundle of dried plants which were picked twenty-five years before, in the deserts about Palestine, and so strong was their fragrance that it filled the room with "Sabaen odors from the balmy fields of Araby the blest."

The historic hemlock of which Socrates drank, loses its virulence when grown in Scotland, and our sassafras loses its odor when grown in the cool summers of England.

Our studies of the relations of plants to climate must deal with acclimation, — a subject held in such different estimation by different observers, that while the eminent Prof. Lindley has great hopes for its future, Peter Henderson declares that "a lifetime spent in the practical study of horticulture has forced me to the conclusion that there is no such thing as acclimation of plants." Corn, for instance, does not succeed in England. This diversity of opinion may arise, in part, from different understandings of what acclimation is. To one, acclimation means an entire change, a revolution in the constitution of a plant, so that it can exist in opposite extremes of climate; to another, it means a series of minor changes, taking place gradually, so that the plant can be cultivated or become naturalized through small but constantly widening circles of differences. The first notion supposes no limits to acclimation. So far as I know it is unreal. The second notion, that of gradual acclimation and naturalization, is abundantly illustrated in every garden and by every roadside. It accepts the common observation that there are limits to acclimation. We cannot grow water lilies on a sand-hill or corn in a damp and cloudy climate. We are not able to say whether we can induce some entirely new change or series of changes to take place, in order that the plant may become accustomed to some radical difference in climate, or whether we simply intensify or draw out some latent tendency to variation, which exists in the plant in wild nature. Of the fact of acclimation, however, there can be no doubt. Plants adapt themselves to colder climates. In fact, the dwarfing consequent upon transference to higher latitudes is itself an adaptation, from the fact that the plant requires a shorter season in which to mature. The individual character of the plant is, in some instances, mysteriously changed. It is stated upon good authority, that twenty degrees below zero in Michigan is no more injurious to a given variety of peach tree, than zero in Mississippi. We have numberless prophetic facts concerning acclimation, but of its possibilities

we know almost nothing. Our science must climb the garden fence to solve the problem. It is possible that we must begin with the seed itself if we would acclimate. It has been thought that the reason why northern-grown seeds germinate quicker than others, in spring, is because the cold of winter produces in the seed an increased sensitiveness to heat and cold. Indeed, individuals of the same species were once kept, some in an ice-house, others in a warm cellar, and the former vegetated sooner and grew faster in spring than the latter. Upon this suggestion I am now experimenting with seeds, cuttings and scions.

If we would fully understand the laws of variation of cultivated plants, — whether the variation is in the direction of acclimation or otherwise, — we must know the origin of the plants; we must know how they have varied in all previous times. The origins of many of our cultivated plants are lost in the mists of antiquity. They antedate civilization; they sprang from untaught nature, coincident with man. The primeval ancestors are lost. We search the records of every ancient people, and our perplexity is often rather increased than diminished. Sometimes history is altogether silent. How, then, can we know the unrecorded past? If man, by cultivation, has evolved our plants from wild nature, why cannot man, by a reversal of that cultivation, breed back to the originals? The common radish is unknown in a wild state. When radishes become spontaneous, or self-sown, about the borders of the garden, they lose many of their valuable characters. Their roots become somewhat smaller, much tougher, and the aspect of the plant is changed. Three acute observers — botanists necessarily — observed that the variations of these self-sown plants are in the direction of a certain so-called wild radish, which is a weed in poor soil, along the Mediterranean and in some places on our own Atlantic seaboard. This plant has a slender, woody root. Thereupon Carriere, a French experimenter, sowed the seeds of this wild plant in the autumn, in good soil. The plant found itself in a new predicament. It could not flower before winter came; and, with the elasticity of organization so peculiarly characteristic of natural objects, it formed a thick root, in which was stored nutriment

for the growth which must be delayed until the next year. Seeds of these plants, and of their offspring until the fourth generation, were sown, when Carriere found himself in possession of perfect radishes! Now we can picture to ourselves the first radish. Seeds of the wild plant became scattered to a fertile soil. They germinated in the autumn. Some person, more acute than his associates, noticed the sleek, thickened root and tasted it. It pleased him; he watched other plants like it; he sowed the seed. Many biennials, — turnips, carrots, parsnips, — sometimes "break" the first season. Instead of producing fleshy roots, they "run to seed." This appears to be a reversion. Seeds from such plants commonly produce annuals instead of biennials.

The poet Goethe and Saint Hilaire proposed a law which states that when nature expends energy in one direction she spares it in another. There is always an equilibrium of force. There is a constant amount of coin in the treasury; and nature, the scrupulous manager, economizes in stocks when she speculates in crops. We need more proof of this statement; we need to know if it is a law. We are already aware that the number of seeds in a cultivated apple or pear are less than in the wild fruits: do the numbers and sizes of seeds decrease in proportion to increase of improvement? Many fruits have become seedless; man has bred out of the plant the power of perpetuating itself. The banana is a familiar instance. We are familiar with the fact that checking growth induces fruitfulness. We produce fruit at the expense of growth. Old and decrepit apple trees often bear profusely, as if in the endeavor to increase their progeny with their last effort. Poor soil and indifferent culture often produce depauperate plants, and such plants usually blossom prematurely. The intelligent gardener is aware of this fact, and is enabled, in many cases, to produce a race or variety of dwarfs. Here is also a promising field for scientific experiment. Given this law, and we shall sow the smallest seeds, from the fewest-seeded fruits, when we wish to secure new varieties. Here the garden fence was first let down, so far as I know, by the New York Experiment Station.

Running alongside these curious facts are others still more curious. We know that a plant becomes variable when it is

cultivated. In their wild condition plants are commonly in a certain state of repose. Grown for centuries under certain conditions, they have become accustomed to their surroundings, fitted into the niche wherein they have found themselves. Their characters become hereditary because they are not disturbed by surrounding objects and conditions. There is a sort of an interbalance between conditions and plants, and when these conditions are changed the probabilities are that the plants will change also. When the tramp got into clean clothes his conditions were changed and he declined to sleep on the sidewalk. Some plants adapt themselves to new conditions more readily than others; they begin at once to vary in habit and character. Others show no change for some time, — for years, perhaps, — when suddenly they begin to vary, and their original identity may soon be lost. During the first years of their civilization they store up variability which will some day break out into forms whose name is legion. This phenomenon has been called the accumulative effect of cultivation, — a good enough name for an occurrence, a fact, for which we have scarcely a hint of a cause. The direction of variation we can determine largely for ourselves. Here, for once, does man lead nature; ignorantly, perhaps, but still leads. He leads the plant in the direction of larger roots, sweeter leaves, finer fruits. He could lead more certainly and more rapidly if he knew the whys and wherefores, the bogs and the quicksands, the hard grounds and the mountains, which lie along his path. But with these greater changes come minor ones, which are in some way related to still greater ones which have not appeared. I wish to call your attention to the fact that as variability increases the pollen begins to vary; that delicate, vital dust, which may float in a sunbeam, or which may be carried a thousand miles on the wings of the wind, is influenced by the behavior of the plant. We know little concerning this wonderful fact; we have a hint which is snugly fenced about. It remains for some one to study, develop and apply it. We cannot trace it to its end even in imagination. We do not know whether this is the first or the last of the phenomena of variation. We do

not know if every successive generation varies more because the pollen which impregnated, fertilized the seed, varied more. In short, we do not know that this variable pollen does induce variability, although we suppose that pollen from a cultivated plant produces a more variable offspring than does pollen from a wild plant.

But what is this cross-fertilization, this cross-breeding, this hybridizing, which is in every one's mouth, and which flits as an undefined something before the eyes of the farmer of to-day? It is nothing new; its literature is voluminous; gardeners will talk about it in the most commonplace and familiar manner. Its influence has been felt for a quarter of a century as a great tidal wave in the science of horticulture. It is simply transferring the pollen from one flower to another, and then sowing the seeds which result from the fertilization: these seeds will probably produce plants in some manner intermediate between the two parents. This is the gardener's definition. It explains itself; we understand it; we have few or no doubts concerning it. The fresh graduate of the high school has finished natural philosophy; he has learned by rote the definitions and the illustrations in Wells or Quackenbos. He knows it all. In all the book there are no doubts; the statements are definite and positive; there is nothing more to be discovered. Between the covers of our little volume lies all our knowledge of the motions and properties of bodies, of the mechanics of levers and pulleys and wedges and screws, of the wonders of electricity and magnetism, of the laws which govern the weather and the features of the heavens: it is all there. The graduate from the college has studied chemistry and mechanics and physics and electricity and meteorology, but his knowledge is unsatisfactory. He is impressed with what he don't know. His knowledge is relative and negative. He has got beyond the covers of the text-book. He sees every branch of his study widening and widening into infinity: there is no end. We are frittering away our efforts on the surface of this wonderful sexual relation of plant to plant, and are contented if, perchance, we reap a result. The ancient farmer tickled the earth with

a sharp stick and was satisfied with his harvest: the farmer before me ploughs deep; he subsoils; he is never satisfied with his harvest. He succeeds best when he weaves no hit and miss into the acres of his farm. The gardener does not know the laws by which the warp and woof are woven into this mysterious fabric which binds plant to plant in sexual kinship. Said Lindley, a pioneer in horticultural science: "Hybridizing is a game of chance played between man and plants." An Englishman crosses his dahlias and sows the seeds. From 30,000 seedlings he gets an average of ten good plants! Another calculates that out of 2,000 seedling cross-bred chrysanthemums he gets, on an average, one good plant. In many cases the ratio of good plants to poor ones is much higher, and in a very few instances we can predict results with tolerable accuracy. Still, the matter is, at best, haphazard; it is not scientific.

There are several degrees of crossing, as practised by man. A transference of the pollen from the anther to the stigma of the same flower is close or self-fertilization; it occurs often in nature, but is rarely practised by the cultivator. If crossing takes place between different plants of the same species, as between a Baldwin apple and a Swaar apple, or a Marrowfat pea and a Tom Thumb pea, the product of the crossed seeds is styled a half-breed; if it takes place between entirely distinct species, as the pumpkin and the squash, pea and bean, the product is a hybrid.

But now we must ask ourselves what a species is. We must define our definition. The botanist tells us that it is a plant which, in wild nature, reproduces itself, or very nearly itself, from seeds, for successive generations. The sugar maple, the apple, the quince, the dahlia are species. But the different sorts of sugar maples, — as the black, the curled, the birdseye, — and the different sorts of apples, quinces and dahlias are not species: they are varieties; some of more permanent and important character than others. Nature makes species, and also varieties, but man can make only varieties. But we have already seen that man can produce varieties which "come true to seed:" we call them races, but why are they not species? Simply because man has

produced them. Many of them we should call species in wild nature. It depends upon which side the garden fence we stand. If we are on the outside we have a species; if on the inside, we have a race. It is like a Chinese paragraph; if we turn it over we must stand on our head to read it. The botanist claims the plant when it is a part of wild nature, but loses his interest when it becomes immediately useful to man. Is this a legitimate division of labor? Is the scientist scientific? Does a horse cease to be a horse when it is put into the harness? But they tell us that the different races of cultivated plants — as, for instance, the Treadwell and Clawson wheats, the Yankee and dent corns — are not distinct enough from each other to be called species; and also that, if left to themselves, they will probably soon return into the species from which they sprang. Certainly many of our races are just as distinct from each other as are many reputed wild species, and we have proof that many of them are just as permanent. What do we know of the fixity of wild species, anyway? Scarcely anything. We have many artificial hybrids which, so far as we know, are just as distinct from their parents as their parents are from each other, which are just as fertile, and which appear just as well-fitted to fight out the struggle for existence. We do not know why these hybrids possess such and such characters, characters which are often wholly different from any which appear in the parents. We say that they date back in some mysterious way to ancestors. Then, let us find out what the laws of this reversion are, that we may make other and better species. At present we cross similar species, under apparently identical conditions, but we get different results. Why is it? Is nature fickle, or is man ignorant? Hubbard squashes long grown in Framingham, crossed with Hubbard squashes long grown in Framingham, may improve our seed; but Hubbard squashes long grown in Framingham, crossed with Hubbard squashes newly introduced from Michigan, will infuse new life into our offspring. This crossing with foreign stock of the same variety is of wonderful importance. It is a principle as boundless in its influence as the science of horticulture itself. Its importance may be

gleaned from the fact that, in one of Darwin's experiments, the height of foreign crossed stock exceeded that of self-impregnated stock as 100 exceeds 52, and in fertility as 100 exceeds 3. The principle is of universal application, and all honor is due to Darwin who gave it to us. We do not know even the limits at which plants can be crossed. Sometimes varieties of the same species cannot be crossed, while some species, or reputed species, cross most readily with other species. In short, we know none of the general laws of cross-breeding, and still we believe that there are such laws. If we must learn some of these laws by experiment, we must also learn some from untrained nature. Our woods and fields are nature's garden. For ages the provident mother has been working with winds and waters and insects, with soils and climates, to breed up and to breed out her plants. She presents to us a grand puzzle. We do not know whence her plants have come or whither they are tending. We do not know how many are hybrids, born from the beautiful marriage of the insect to the flower; how many are the children of a peculiar clime; how many had their origin in a recent century, or in distant geological time. We are groping, interrogating. Every question which is answered in the woods and fields is answered for the garden. One spirit pervades vegetation. We can scarcely draw a line between cultivation as practised by man and cultivation as practised by nature. "Our art," said Shakespeare, "doth mend nature, change it rather; the art itself is nature." We must get outside the garden fence as well as inside it. We must demolish the line between science and practice. This is the new horticulture. Deep down in nature's heart, beneath the thorns and perplexity, truths are hid which are vital to the farmer and gardener. Then do not discourage the pursuit of science, however much you may have been taught to regard it as opposed to practice. Science is practice. All so-called popular and useful science must be founded upon recondite facts and principles. The more we know of nature as nature, the more readily can we understand nature in the garden.

We fail to catch the butterfly if we chase its irregular

flight over the meadow, but the still hunt beside a thistle will bring us a captive. We cannot always reach the result at which we aim in experiment by a direct chase; we quite as often succeed by employing the still hunt of collateral evidence. The experimenter, then, must be a man of skill and learning in more directions than one. To reach the best results he must give his whole time and energies, The college professor, with his classes and his daily routine, can accomplish but little. We must delegate the work to the forthcoming experiment stations.

We commonly look upon the science of botany as affording few avenues for practical research, while we applaud to the skies the results attained by chemistry and entomology. But chemistry often fails just where we expect the greatest results. The chemist finds turnips to be composed largely of water, and declares that they cannot be profitable food for stock; but the old Scotchman, whose turnip-fed sheep are sleek and robust, knows better. The potato is three-fourths water; but it is indispensable, because it presents a digestible bulk to the stomach. Chemistry cannot analyze the grip of a man's stomach. Of all science under heaven, there is none more eminently practical than this same botany. Many people don't know what botany is; they associate it with the school-girl accomplishment, which aims to chase down a few plants to their Latin names, and to press them in a little book, which is sacrilegiously styled an herbarium. This work bears no more relation to botany than does a party platform to party practice. Botany teaches, not only what a plant is, but what it does and how it does it. There is one botany of names and classification, another of cells, another of the plant as a living and growing organism, and another of mutual relations to all environments. All these are given for the use of man, because he deals with plants in all their aspects. Even some botanists tell us that the botany of names and classifications — the botany of species — is well-nigh finished; but when we have named and described every plant upon the face of the earth we must find out what a species is.

The garden is a puzzle. Every leaf and flower is an

interrogation point. And why is this true, when we know so many facts in horticulture? Our experiment has been conducted by our so-called practical rather than scientific men. The end and aim of experiment has been to secure more profitable products, rather than to disclose the principles which govern the production of such products. Had we reversed these motives of experiment, had we endeavored to find the why, our horticulture would be much in advance of its present position. Do you understand me? Do you understand that it is more necessary, at present, to discover laws than to strive directly for better fruits and vegetables?

The difficulties in horticulture keep pace with the advancements in horticulture; the more we know the more we do not know. We shall experiment and investigate for a century; we shall solve the riddles of to-day: what, then, shall the horticulturist of the future investigate? We do not know what his puzzles will be, but we know that he will have puzzles. Science is ever new. It has no depth, no height, no boundaries; it stretches away into the infinite. We no sooner uncover one truth than we discover another. Man always anticipates his extremity of want but never reaches it. Before we exhaust the coal and oil which mother earth has locked in her bosom, we grasp the electric current from the air. Before we shall exhaust our iron and copper we shall learn an easy method of extracting the silver from clay. Man shall always strive. Endeavor is a winsome goddess, who leads us through copses and along hazardous banks, but she never leads us to the ends of nature. The man who loves his garden, and who knows some of its secrets, is impatient for a fuller gratification. Some objects are near at hand and well defined, others are misty on the horizon. He tries to grasp them; they flit away like a pleasant dream; the prosaic garden fence is before him.

Adjourned to Wednesday, at nine o'clock.

SECOND DAY.

The meeting was called to order at nine o'clock by Mr. S. B. Bird, who introduced Prof. C. A. Goessmann, of Amherst, as the first lecturer.

ON ROTATION OF CROPS.

BY PROF. C. A. GOESSMANN OF AMHERST.

The practice of raising upon the same lands, for any length of time, in succession, the same variety of plants, or crops of a similar character, has proved ultimately disastrous everywhere. It is an old observation in agriculture that a given area of land produces, in the majority of cases, more satisfactory crops when planted from year to year with a different kind of plants; and it was not less understood in ancient times, that one series of crops raised in succession gave better returns than another.

The beneficial influence of a periodical rest in the cultivation of farm lands, as far as their productiveness is concerned, was also recognized at an early date. Ancient writers on agricultural topics speak highly, and not infrequently very intelligently, of the good services of fallow in the management of farms; they point out why gardeners, on account of the great diversity of crops they raise, and of a more thorough mechanical treatment of the soil they cultivate, feel less the necessity of fallow, than farmers engaged in the raising of a few grain crops.

Comparing many of our customary modes of treating our lands with a view of promoting their fertility, with those in use for a similar purpose in more remote ages, we find that they are time-honored, and not unfrequently of hundreds and even of thousands of years standing. The merit of having introduced into the agricultural practice of to-day irrigation, underdraining, fallow and subsoiling, in the interest of an economical development of the inherent or latent sources of fertility in the soil under cultivation, has been duly credited to preceding centuries; the same circumstance may be justly

asserted with reference to the introduction of a rotation of crops, and of the cultivation of deep-rooting and foliaceous forage plants, for the purpose of economizing advantageously various résources of plant food. Careful observation in the field, and actual trials carried on through ages, have steadily added to their appreciation in farm practice, and contribute much towards a judicious decision regarding the most advisable course of operation to meet efficiently local circumstances and special requirements.

Whilst we thus have to yield to previous centuries these points in regard to our present farm practice, we can assert with not less certainty, that during our present century much more progress has been made in recognizing the principles which underlie the previously mentioned modes of operation in farm management, than during all preceding periods in the history of agriculture. Their well-known failures in preceding ages were in a controlling degree due to a want of means to gain a deeper insight into their peculiar mode of action. The mere statement of the fact that the chemical composition of the water and of the air became only known at the close of the past century, and that a proficiency in ascertaining the constituents of soil and of plants could only be claimed by comparatively few chemists even as late as 1830, will suffice to show the possibility of the times.

The important bearing of these circumstances on the contemporary conditions of agriculture is to-day so well recognized, that we expect to meet an unqualified endorsement when we assert, that the attainment of more satisfactory results in our agricultural industries of to-day, aside from improvements in agricultural implements, is mainly due to a better knowledge concerning the composition and the general characteristics of the air, the water and the soil, and the relations of these agencies to plant life, besides a more correct appreciation of the mutual dependence of an economical production and support of plants and animals, in an ordinary mixed farm management.

The progressive farmer of the present generation has greatly improved his chances of success by calling, for assistance in his varied and complicated field of industry, on the

scientific investigators in every department of natural and physical science. The best experimental resources of to-day serve as his guides.

He understands it well, that although it is an undeniable fact that horticulture was for ages recognized as a highly developed art, before botany deserved the name of a science, that the latter has rendered of late most valuable services regarding a more correct understanding of the phenomena of plant life in general, as well as the particular relations of important families of farm plants to each other in farm economy; and he is not less prepared to concede that although barnyard manure, wood ashes, salt, gypsum, marl, lime and bones were known as manurial substances to writers on agricultural operations of ancient Rome, that modern agricultural chemistry has thrown a new light upon the subject of the fertilization by these means, showing their true relation to the chemical and physical conditions of the soil which receives them, and to the crops raised upon it, and reducing the entire question of an efficient manuring of our lands to the one principle, — "restitution."

We recognize to-day, as the basis of a successful cultivation of farm crops, the necessity of restoring to the soil those of its constituents which the crops raised upon it have abstracted.

To prove the existence of these relations, and to show how to comply with their requirements, is the work of scientific investigators of a more recent date. The results of these investigations, which are still going on in the present, do not directly antagonize any particular system of farm industry; they furnish, on the contrary, in many instances, a safer guide for farmers to choose a branch of agricultural industry, and a system of cultivation best adapted to their local and personal resources. All are, however, subjected to one common rule, as far as the successful cultivation of farm crops are concerned, — they have to comply with the unalterable relations which exist between demand and supply; for each kind of crop, although in its own way, tends to exhaust the soil sooner or later. Rotation of manures has to a considerable extent lessened the necessity of a rotation of crops, and modi-

fied the selection of crops for an economical system of cultivation.

The early history of agriculture points everywhere towards two distinct systems of industry; namely, the cultivation of grain crops, and the raising of animals for the production of food for the support of the human family. Both systems, at first more or less independent of each other, subsequently merged gradually into one, in most localities, and laid thereby the foundation to the most extensive system of agricultural industry, — the mixed farm management.

Increase in population, progress in civilization, diversity of soils and climate, local demands of markets, personal fitness and pecuniary resources of farmers, have been instrumental in the development of quite a number of more or less reputed systems of farm practice, to meet the requirements of the times. All existing systems of agricultural industry of to-day differ mainly in regard to the following circumstances: *First*, the exact period when fallow shall return, or whether it shall be entirely discarded in the management of the lands under cultivation; *second*, the mode of securing the needed fodder for the farm live stock, — whether it is to be supplied entirely or in part by pastures and natural meadows, or by raising additional fodder upon cultivated lands; and, *third*, the particular order in which the various crops selected for the special industry carried on are to succeed each other upon the lands assigned for that purpose.

The older systems of farm practice, still in use in localities less advanced in agriculture, rely in a great measure on a frequent recurrence of fallow, as a means of recuperating fertility in a more or less exhausted soil; those of a more recent date depend less on a development of inherent dormant soil resources of plant food by natural or atmospheric agencies, but supplement them more or less by additions of suitable plant food, in form of commercial fertilizers, or indirectly by buying fodder for the farm live stock, to replace, in an economical way, those soil constituents which have been sold from the farm in the form of crops. As most of the older systems of farm management are either obsolete or still confined to only a limited area, and thus, in

the majority of cases, largely of a mere historical interest, a farther detailed discussion will be omitted.

A system of raising farm crops can only then be called a rotational one, in the light of our present experience, when it tends to secure the production of the largest amount of valuable vegetable matter at the lowest possible cost, in connection with a due attention of returning to the soil those of its constituents, in a suitable form, which the crops raised upon it have abstracted. To attain this end in a measurable degree, imposes the compliance with two important conditions; namely, a successful adaptation to soil and climate of the crops selected for the special farm industry, and remunerative market prices for the products obtained.

Considering these two conditions of success equally applicable to all branches and special systems of agriculture, it becomes quite obvious that on account of the great difference in local and personal resources, no one definite rule can be laid down for either the selection of the best adapted system of farming, nor for the best arrangement of the succession of the various crops chosen, which promises to be the best under all circumstances; there are no unfailing receipts on these points.

Taking this view of the subject under discussion, I propose to relate in a few subsequent pages some of the more recent scientific inquiries into the principles which underlie a successful application of well-known and reputed agricultural modes of operation, and their relation to a remunerative rotation of crops.

Fallow. — One of the oldest modes of maintaining the productiveness of lands is known by the name of fallow. This name has been applied, however, in the course of time, to so widely differing treatments of the soil, that it seems desirable, in the interest of a judicious decision concerning its claims for a consideration in this connection, to describe shortly the management of fallow land, from its first introduction down to the present time.

Judging in particular from the writings on agriculture of ancient Rome, we notice that it was originally applied to cultivated lands, which were left for one entire year, — from autumn to autumn, — *unseeded*, whilst the soil was

turned over directly after harvesting the last crop, and during the succeeding summer season repeatedly ploughed and harrowed before seeding it down again. The period for that treatment of the soil recurred in different localities and at different times, at intervals of from one, two or three years; the three years' course, with one year of winter grain and one year of summer grain, in rotation, it is stated, became already quite prominent in the agricultural practice of Europe during the ninth century; and it has come down to our time in some localities, on both sides of the Atlantic, with but little modification. Wherever that treatment of the soil gradually failed to secure, in a satisfactory degree, a frequent production of remunerative grain crops, the fallow time was extended over several years, and frequently a growth of natural grasses allowed to cover the lands. The latter were left unploughed, and served quite frequently for pastures; yet the lands thus treated were commonly called "fallow lands" and the pastures "fallow pastures."

This system of farming was continued until, in consequence of an unrestricted production and sale of grain crops, the natural resources of the fertility of the soil became exhausted; and as long as new lands at low cost enabled a repetition of the operation. A scanty production of manure was the inherent cause of its ultimate universal failure.

The unremunerative character of a frequent recurrence or long duration of fallow made itself, quite naturally, first felt near centres of a denser population, where an increase in the price of land called for changes.

The first step, or real progress, is marked by the introduction of *manure* into fallow lands. The period of fallowing was reduced to one season, and the manure thoroughly distributed in the soil by repeated ploughing and harrowing. The area allotted to grass lands was subsequently greatly enlarged, and thereby the chances of keeping more live stock efficiently improved. As long as the meadows held out, the new shift succeeded well; as soon, however, as the grass lands began to fail in producing good crops, a

scarcity of manure made itself felt again, and a new change of the system became advisable.

Fallow lands were subsequently made to produce, during part of the year, either some suitable crop, — summer grain, etc., — to serve as a green manure by ploughing it under, or some less exhausting fodder crop, as beans, pease, vetches and clover, to furnish more fodder and subsequently more manure; thus were introduced green fallow and fallow crops.

The system of fallow, as originally applied, was evidently introduced for the purpose of improving the mechanical and general physical conditions of the soil; for the destruction of obnoxious weeds and insects; and for an increased preparation and accumulation of inherent resources of fertility to secure better crops. The beneficial influence of repeated ploughing, etc., on the mechanical condition of a heavy, clayish soil, in particular, is to-day still recognized, and, in some exceptional cases, still considered indispensable for a successful cropping; not less is still appreciated its good services for the retention of moisture.

As a means for an increased production of available plant food, by the disintegration of soil constituents, it is only of interest in the case of naturally rich soils; for experience has fully demonstrated the fact that growing plants, by their root system, act more powerfully in disintegrating the soil, and liberate more plant food, than the ordinary agencies of the atmosphere, as carbonic acid, oxygen, water, and changes of temperature, when acting on tilled yet unseeded lands. The destruction of obnoxious weeds is to-day surer attained by close cultivation, drill culture, and by the introduction of hoed crops in our system of farm practice.

The fallow system is, in the majority of cases to-day, too costly to deserve an unqualified recommendation; it is excusable only where manure in sufficient quantity cannot be obtained at a remunerative cost, or where the character of the land is such that manuring does not pay.

We recognize fully the importance of a naturally good soil, and concede that the natural and inherent yet still inactive resources may be made, by proper treatment, quite

frequently valuable helpmates for the production of crops; yet they have proved ultimately insufficient to produce remunerative crops for any length of time, without the assistance of outside supplies. The endeavor to save the best feature of the fallow system led gradually to the development of the system of a rotation of crops.

Rotation of Crops. — Experience in agriculture teaches that most of our farm crops, even when properly manured, cannot be raised upon the same lands for any length of time, in succession, without a gradual decline in the annual yield, and an ultimate entire failure. The soil becomes, for some reason or another, unfit for a economical reproduction of the same plant. The exact time when this circumstance happens must vary, quite naturally, widely; for soil, climate, more or less thorough system of cultivation, as well as the general character of the plant, each in their own way bear on the final result. Potatoes have been raised, without any interruption, upon the same lands upon Helgoland, since their introduction in 1806. Wheat follows upon wheat for ages in Egypt. The same is true in regard to rice in China; to corn in Mexico, and to barley in some localities in Greece. However interesting the reports concerning these statements may be considered, they do not change the force of the above verdict of experience.

Taking our information from past ages, we notice the fact, that, as a rule, the more limited the varieties of plants selected for a system of farming, the sooner did the industry become unremunerative.

A comparison of the results obtained from lands of a corresponding general character, engaged in the raising of a variety of garden crops, with those used for the production of a few grain crops, suggested already, at an early date, the idea that the comparative continued success in raising a large variety of garden crops, in sight of a more frequent failure of a few grain crops in the contemporary system of farm management, could not be due to the operation of different laws of nature, but might be the result of a more careful mechanical preparation of the soil in garden farming, and the raising of a greater variety of plants, requiring

different conditions of the former for their successful growth.

The attempts to select additional new crops, best adapted to the existing local conditions of soil, climate and the contemporary demands of the markets, led, in the course of time, to a variety of systems of cultivating more or less kinds of crops in some definite, regular succession, upon the same lands, and repeating that course in the same order, over again, with more or less success.

Thus we find at first a two-years field course, — one year summer or winter grain, with one year fallow. Subsequently, a three-years field course, — first year, summer grain; second year, winter grain, with manure; third year, fallow, with or without manure. Still later on, we find a substitution of fallow by fodder crops or hoed crops, or by cultivating both together, with summer and winter grains. The introduction of clover and potatoes mark here a new era in agriculture.

The reputed original four-years "Norfolk" course, which consisted of —

First Year. Root crops (turnips, rutabagas, etc.);

Second Year. Summer grains (barley, etc.);

Third Year. Fodder crops (leguminous plants, clover, etc.);

Fourth Year. Winter grains (wheat, etc.);

belongs here.

With an increasing development of a more intensive system of farming, and a better appreciation of stock-feeding as an important factor for the improvement of farm lands, even more prominence has been given to other than grain crops, assigning to them, in some instances, two-thirds of the entire area of lands under cultivation. In some reputed systems of rotation does the course, upon one and the same piece of land, extend over ten and more years.

As each system of rotation of crops, if intelligently worked out, rests its claims of particular merits, as compared with others, on a careful consideration of local resources and conditions, but little interest can be aroused by discussing their respective advantages on an occasion like the present, where a limitation of time excludes the

presentation of such details of facts as would be desirable to arrive at judicious decision regarding the subject under consideration; besides, elaborated systems of rotation of crops, covering a series of years, are mainly of interest and of particular benefit in case of large estates.

It is for this reason, in particular, that I do not undertake the task of describing more in detail some of the many systems of rotation which have acquired a local and, in some instances, even a national reputation, but propose to discuss shortly some of the causes why a rotation of crops tends to increase the chances of rendering the raising of farm crops more successful, and thus more remunerative, than any of the older systems of field management; and to conclude with a few suggestions of a practical character regarding a proper order of succession of farm crops, gathered from experience on well-managed farms here and elsewhere.

The causes why many of our prominent farm and garden crops may be raised with a better prospect of success upon the same lands, by adopting a well-considered course or order of succession, rests mainly on the fact that it presents a better chance to regulate the chemical and physical conditions of the soil, with reference to the kinds of crops to be raised; for a judicious system of rotation assigns to each crop that position in the course decided upon which promises to benefit most by the existing conditions of the soil. It aims at an economical application of the natural resources of plant growth in soil and atmosphere, by alternating the crops with reference to both. Crops are following each other, not only with reference to one year's result, but also with a view of improving the general condition of the industry adopted.

To attain this end with a fair prospect of success, we have to make ourselves, as far as practicable, familiar with the following points: —

1. Relations of the mineral constituents of the crops to the composition of the soil. 2. Relation of the botanical characteristics of the plants to the composition and physical condition of the soil. 3. The character of the manures at our disposal.

1. *Relation of the mineral constituents of the plants to the composition of the soil.*

All our cultivated plants require for their growth the same soil constituents; they differ however, decidedly, not only in regard to the absolute amount which they abstract, but also in regard to the relative proportion of the same essential elements. Boussingault found, by actual observation, that upon the same field (2.5 acres), by one manuring, in five succeeding years, the following quantity of soil constituents had been abstracted:—

First year, Potatoes (without stems),		246.8 lbs.
Second year, Wheat (grain and straw),		371.0 "
Third year, Clover,		620.0 "
Fourth year,	Wheat (more straw),	488.0 "
	Turnips,	108.8 "
Fifth year, Oats (grain and straw),		215.0 "
Total,		2,049.6 "

(The difference of 117 pounds of soil constituents between the first and second wheat crops is explained by the larger amount of straw as compared with the grain.)

Under similar conditions an average crop of beet roots, without leaves, had abstracted 399.6 pounds of soil constituents; peas (with seed and straw), 618 pounds of soil constituents; and rye (grain and straw), 284.6 pounds of soil constituents.

Dry stems and leaves, as a rule, contain several times more ash constituents than the grains and fruits of the same plants; young plants contain usually much larger quantities of ash constituents in proportion to their organic matter than in their matured state.

One thousand parts of air-dry vegetable matter contain, in case of meadow hay, from 45 to 65 parts mineral soil constituents; clover hay, from 45 to 80 parts mineral soil constituents; grain crops (seeds), from 12 to 20 parts mineral soil constituents; grain crops (straw), from 40 to 50 parts mineral soil constituents; root crops and potatoes (without leaves), from 6 to 10 parts mineral soil constituents;

tobacco (stems, dry), from 60 to 70 parts mineral soil constituents; tobacco (leaves, dry), from 140 to 150 parts mineral soil constituents.

One hundred weight parts of the mineral constituents of the following important groups of farm plants contain, on an average, alkalies, lime, magnesia, phosphoric acid and silicic acid, in the following proportions: —

		Alkalies.	Lime.	Magnesia.	Phosphoric Acid.	Silicic Acid.
Grain crops: wheat, rye, oats, etc.	Grain,	30	3	10	50	–
	Straw,	20	5	2	3	60
Leguminous plants: pease, beans, clover, etc.	Seeds,	45	5	8	40	–
	Straw,	30	35	8	10	5
Hoed crops: roots (or tubers),		60	3	5	15	10
Potatoes, etc. (leaves and stems),		25	40	3	3	20
Root crops (roots),		50	10	3	10	5

The amount less than one hundred per cent. consists of iron, chlorine and sulphuric acid. The fact that these constituents are liable to vary within certain limits does not interfere with the purpose for which they are stated above.

The relation of phosphoric acid to potassa are in the following crops as subsequently stated (in average crops): —

	Potash.	Phosphoric Acid.
Wheat Grain,	1	1½
Wheat Straw,	2	1
Potatoes,	3	1
Sugar Beets,	4	1
Fodder Corn,	4	1
Indian Corn (grain),	1	1½
Clover Hay,	3½	1
Meadow Hay,	4	1
Tobacco,	5–7	1

Tables showing the quantity of fertilizing material removed by the seed, stem and entire plant of various crops. (For Massachusetts.) [According to Wolff.] (Based on the average crop for 1871.)

Crop.	Average yield per Acre. Pounds.	Substances Removed by the foregoing Crops, from One Acre (in pounds).			
		Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.
Corn — Seed, . .	1,920.80	261.23	30.73	6.34	10.56
" Stalks, . .	5,122.13	717 10	24.58	85.03	19.46
" Total, . .	7,042.93	978.33	55.31	91.37	30.02
Wheat — Seed, . .	1,092.00	156.16	22.71	6.00	8.95
" Straw, .	2,275 40	320.83	7 28	11.15	5.23
" Total, . .	3,367.40	476 98	29.99	17.15	14.18
Rye — Seed, . .	1,008.00	150.19	17.74	5.44	8.26
" Straw, . .	2,352.00	354.41	5.64	17.87	4.42
" Total, . .	3,360.00	504.60	23.38	23.31	12.68
Oats — Seed, . .	1,004.80	140.67	19 29	4.22	5.52
" Straw, . .	1,507.20	212.52	6.03	11.62	2.71
" Total, . .	2,512.00	353.19	25.32	18.84	8.23
Barley — Seed, . .	1,161.60	168.43	17.65	5.57	8.36
" Straw, .	943.80	132.13	4.53	8.78	1.79
" Total, . .	2,105 40	300.56	22.18	14.35	10.15
Buckwheat, . .	720.00	101.52	10.37	1.51	3.17
Potatoes — Tubers, .	7,560.00	5,670 00	24.19	42.33	13.60
Tobacco — Leaf, .	1,450.00	261.00	50.20	78.44	10.29
Hay — Total, . .	1,920 00	276.48	25.15	32.83	7.87

As the rotation of crops is based on the fact that each plant under cultivation has its lowest limit for every article of plant food to succeed well, and as not two species of plants do correspond exactly in that respect with each other, it becomes quite obvious that analytical numerical statements like those above can assist as a valuable helpmate in arranging our farm crops in an advantageous order in any system of farming.

Considering, for instance, the previously stated numerical relations of phosphoric acid and potassa in the mineral constituents of several prominent farm crops, — meadow hay, fodder corn and beetroot, — we find that they contain, practically, both constituents in the same relative proportion; namely, four parts of potassa to one of phosphoric acid.

Assuming, for the sake of illustration, that the soil which shall serve for the experiment contains its available phos-

phoric acid and potassa in a similar proportion (1:4), the cultivation of these three crops must render the soil poorer in both constituents, and render the latter, sooner or later, entirely unfit for their remunerative reproduction.

Quite different would be the result in case potatoes or some leguminous crop — as clover, pease, beans or vetch — had been raised as first crop upon that soil. In that case its phosphoric acid would be abstracted in a larger proportion than its potassa; it would grow thus richer in potassa, and might serve subsequently well, if otherwise fit, for the raising of tobacco. On the other hand, if tobacco had been the first crop, phosphoric acid would have increased in proportion, and the potassa been reduced. Under these circumstances, a grain crop would be a safer crop to succeed than either fodder corn or grass, — except an additional supply of potassa was secured from some outside source to restore the desirable relative proportion between phosphoric acid (one) and potassa (four).

The fact that a one-sided exhaustion of the soil is a quite prominent source of the failure of crops was noticed during the past season in connection with some field experiments upon the grounds of the State Agricultural Experiment Station at Amherst. A short description may not be without some interest on this occasion.

In one instance, a piece of worn-out grass land, which for several years past had not produced as much as one-half of a ton of hay per acre, the grass dying out prematurely in the last year, was to be added to a series of experimental plats with an excellent mechanical condition of the soil, without adding any manure from outside sources. To secure a mechanical uniformity of the soil between old plats and new addition of land, the old, worn-out grass land was ploughed early in the spring, thoroughly harrowed, and at once seeded down in drills, in part with horse bean and in part with white lupine. Both crops being kept clean by means of a cultivator, proved a remarkable success, and formed a marked contrast to the previous grass crop.

Another interesting illustration of the influence of raising one and the same crop upon the same land, on the quantity and quality of available plant food of the latter, was furnished

in conection with experiments upon the grounds of the Experiment Station to test the retentiveness of the soil with reference to single articles of plant food, — as phosphoric acid, potassa, and various forms of nitrogen.

A piece of underdrained land, previously kept for years in grass, which had been subdivided in eleven plats, each one-tenth of an acre in size, was for three preceding years planted with fodder corn, without using manure of any description.

During the past season three plats received a fair amount of a nitrogen compound as fertilizer. One of these received sulphate of ammonia; another one (Chili saltpetre), nitrate of soda; and the third one, blood. The actual amount of nitrogen was the same in each case. A fourth plat received a fair amount of soluble phosphoric acid in the form of dissolved bone-black; and the fifth and sixth plats received each corresponding amounts of potassa in the form of either muriate of potash or of sulphate of potash.

These six plats were separated from each other by plats of an equal size which had not received a fertilizing material of any description for four years. Alongside of that piece of experimental plats was planted a field of fodder corn of the same variety as upon the former. It was well manured with barnyard manure, supplemented by commercial fertilizers, to secure a good crop. The seed corn being of one and the same lot, proved to be good; the young corn started well; yet soon a decided difference became noticeable between the growth of the plats fertilized with nitrogen in various forms, and with phosphoric acid, on one side, and the two plats fertilized with potash compounds on the other. The former did not differ from the unfertilized plats at the close of the season. None produced well-developed ears. There was no marked difference in their final yield. The two plats fertilized with potash salts alone looked healthy and vigorous throughout the entire season, and yielded a fair average crop. It compared at any time well with the crop upon the well-manured fields in its vicinity.

This result shows plainly that more potassa was mainly wanting, in our case, to secure a satisfactory crop; and it furnishes also a good illustration of the fact that, under otherwise corresponding circumstances, one of the essential

elements of plant food requires the closest attention in our system of manuring, which is most liable to become deficient in the soil, either in consequence of an excessive demand on the part of the crop we raise, or on account of the slow supply from inherent soil resources.

An unrestricted cultivation of grain crops, accompanied by an extensive sale of the grains from the farm, brought the phosphatic fertilizers (superphosphates, etc.) into popular favor; and an increased production of fodder and hoed crops, as well as garden crops in general, has given of late a deserved prominence to potash compounds as a valuable manurial substance.

2. *On the relation of the botanical characteristics of our cultivated plants to the chemical composition and the physical condition of the soil.*

The chemical analysis of our cultivated crops gives us, as has been shown in previous pages, an insight into their action on the constituents of the soil; yet, however important this information must be considered, it is but the first step towards a safer basis for deciding the most advantageous order of succession regarding the crops chosen for cultivation.

The natural qualification of the plants to appropriate their food from soil and atmosphere, as well as the time required to reach the desired state of maturity, are points of not less importance to consider in this connection.

On Root-System. — Plants with an extensive root-system, either in lateral or horizontal direction, or both, are better qualified to secure their essential mineral constituents from the soil than those with a limited one. The frequent observation in practice, that, of two crops which require the same essential mineral constituents in a similar proportion for their growth, one yields still a good crop when the other one fails, finds, quite frequently, its explanation in this circumstance. Potatoes may still prosper where beetroots fail, and rye yield still a satisfactory crop where the raising of wheat does not any more pay; although in both instances are required a similar amount of essential mineral constituents. Potatoes develop an extensive root-system in the upper layer of the

soil, whilst the beetroots, like all our root crops, feed largely upon the subsoil.

On the other hand, the root-system of the wheat is compact and consists of fine root branches, whilst that of the rye is loosely constructed and extends through a larger body of soil.

These circumstances explain the well-known fact why wheat prospers best on a compact but rich soil, whilst rye is less exacting with regard to the character of the soil, whether heavy or light; although an average crop of rye abstracts, under corresponding circumstances, usually a larger amount of potassa and phosphoric acid, with an equal amount of nitrogen, than an average crop of wheat.

The examination into the structure and the extension of the roots of our farm plants, has given most valuable suggestions in regard to an economical system of rotation.

The advice given by experienced farmers, to raise wheat direct after deep-rooting leguminous plants, — as clover, luzerne, serradella, vetch, pease, beans, cow pea, etc., — and as a rule not after hoed crops, — as potatoes or roots, — is in full accordance with the chemical and botanical characteristics of that plant. Hoed crops, if early enough harvested to allow the seeding down of winter grains, are apt to leave the soil too loose for wheat, and thereby increase the danger of winter-killing.

Deep-rooting plants, in consequence of their extended root-system, abstract largely their food from the lower strata of the soil, and carry it to the upper layers. They tend to enrich the latter at the expense of the former. It is for this reason but natural that hardy feeders, with a shallow root-system, like most of our grain crops, should follow first in order after the cultivation of deep-rooting plants.

Aside from this result we notice, also, that they exert directly a beneficial influence on the entire body of agricultural soil within reach of their roots. The latter, by penetrating into the subsoil, expose it to the influence of the atmospheric agencies, as oxygen, carbonic acid and germ activity, and favor thereby the production of additional plant food. The decomposition of a comparatively large quantity of vegetable matter left upon the field in form of stubble and

roots, as well as the reaction of the agencies of the air on the newly opened subsoil, tends to raise the temperature of the entire soil.

Both chemical and physical properties of the latter are benefited usually in such a degree, that we quite properly look upon this class of plants as most valuable helpmates for an economical cultivation of farm lands.

The subsequent tabular statement is not without interest in this connection : —

Weiske's Statement in regard to Root and Stubble Refuse left in the Soil by the following Crops.

CROP.	Roots and Stubble.	Mineral Matter (and Earth).	Organic Matter.	Nitrogen in Vegetable Matter.	Lime.	Magnesia.	Potash.	Soda.	Sulphuric Acid.	Phosphoric Acid.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Rye, . . .	4,830	1,512	3,400	62	69	14	30	40	12	24
Barley, . .	1,827	350	1,515	22	40	5	9	3	5	11
Oats, . . .	3,467	1,325	2,200	25	81	12	24	17	8	28
Wheat, . .	3,200	1,000	2,240	22	72	10	17	11	7	11
Buckwheat, .	2,015	427	1,630	45	75	7	9	4	6	10
Pea, . . .	2,960	616	2,400	53	68	11	11	7	9	14
Lupine, . .	3,250	506	2,800	58	76	12	16	3	7	13
Red clover, .	8,186	1,762	6,580	180	246	46	77	19	24	71
Luzerne (Alfalfa)	8,870	1,104	7,770	125	181	22	24	25	17	36
Cultivated saint-foin, . .	5,442	940	4,500	113	108	29	39	13	19	28
Serradella, . .	2,872	500	2,371	60	74	13	8	5	9	14

(Statement applies to one acre.)

In recognition of the importance of deep-rooting plants for the economical production of farm crops, as well as valuable fodder plants, a series of experiments has been introduced at the State Experiment Station to test the adaptation of some new varieties to our soil and climate. (See First and Second Annual Reports of Mass. Experiment Station.)

On Leaf-System. — As the leaves of plants stand in a similar relation to the assimilation of the plant food of the

atmosphere (oxygen, carbonic acid, and some nitrogen compounds) as the roots to those of the soil, it is but judicious to take also into consideration the leaf-system of our cultivated plants, when selecting crops for a rational order of rotation. Plants with an extended leaf surface absorb more atmospheric plant food than those with a small and limited leaf growth; their cultivation tends to enrich the soil with nitrogen compounds and humus.

Broad-leaved and foliaceous plants of the two great families of Leguminosæ (clover varieties, pease, beans, vetch, lupine, etc.) and of Cruciferæ (mustard family, beetroots, turnips, cabbage), besides representatives of others, as potatoes, carrots, parsnips, corn, sunflower, etc., absorb more from the air than our grain crops, and can therefore better depend for their supply of nitrogen on that source than the latter. They are good crops to precede grain crops in rotation, although they contain usually a much larger amount of nitrogen in their annual crop than the latter, on account of the larger weight of the annual yield of vegetable matter.

Broad-leaved plants improve also decidedly the physical condition of the soil they are raised on; they shade the land against the hot rays of the sun during the day, in the summer, and retard the loss of heat by radiation from the soil into the air during the night, regulating thereby the atmosphere of the former in the interest of a successful growth. They economize the moisture of the soil by reducing the chances of evaporation, — a circumstance which protects these crops not only against the serious influence of a drought after they are once fairly under way, but leaves the soil in the best possible condition for the succeeding crop, as far as its state of moisture is concerned.

Well-regulated summer heat, in the presence of a moderate amount of moisture, and a free access of air, are most powerful agents for a rapid disintegration of the vegetable matter of the soil. Adding to these valuable features the fact that well-shaded grounds, in consequence of a close cultivation, assisted by a frequent use of the cultivator or the hoe, as circumstances may advise, are known to be most efficient means to subdue the growth of weeds, it becomes

quite obvious that their introduction, in the course of rotation, directly after winter or summer grain crops, or crops which in a similar degree favor the development of a foul growth upon cultivated lands, deserves, for various reasons, high commendation.

Having briefly discussed the importance of the character of the roots and leaves of our farm plants in an economic system of rotation, it remains for me to call, in this connection, also, attention to the duration of growth as an important point deserving a serious consideration in the management of farm land.

Some of our farm plants pass through the various stages of plant life from germination to the maturing of the seeds in one season; some require for the same purpose two seasons; others produce flowers and seeds for several years in succession. Some crops are gathered after the seeds are matured (grain crops), others before blooming (root crops, etc.), and others furnish crop for more or less years, by sending up new shoots or branches. Close investigations into the requirements of plant growth, have shown that plants do not only differ from each other in regard to the absolute and relative quantity of the same essential articles of plant food, but also in regard to the period of growth, when more or less of one or the other is needed.

Plants which are but short-lived or reach their maturity within a few months, require, for this reason, a soil rich in those constituents which are essential for their normal development; plants which need from five to six months to pass from seeding down to the harvesting of their seeds, are better fitted to benefit by the supply of plant food from the natural resources of soil and of air, than those which reach their maturity within three months after seeding.

Summer grains on one side, and grass lands, orchards and forests on the other, represent the extremes in this direction in our farm industry. Grain lands respond better to a liberal manuring than grass lands. Lands well adapted to grass growth necessitate the smallest expenses for manure to return remunerative crops, — a circumstance which imparts to natural meadows a particular value in farm management; they not only turn the natural resources of plant food

to the best account, but can aid in the production of home-made manures to benefit all parts of the farm. This consideration leads us to a short discussion of the third point mentioned as worthy of a careful attention when planning a course of rotation of crops.

3. *The character of the manures at our disposal.*

The investigation into the composition of the plants we cultivate, and their relations to the chemical and the physical conditions of the soil which has served for their production, has drawn, as we have noticed, a new light upon the question: How can we promote most efficiently, in an economical way, the production of field and garden crops?

We have learned by actual tests that the best results, in growing plants of any description, are obtained by providing a liberal supply of every essential article of plant food at the time when needed for some physiological function in the life of the plant under cultivation. To meet the periodical wants of the plant is a first condition of success.

Grain crops require, in particular, phosphoric acid and nitrogen at the time of blooming and the formation of the seeds; fruit-bearing plants, like grapevines, at the corresponding period, for the same purpose, need potassa. This is one of the reasons why a liberal manuring pays better than a scanty one.

A rational system of rotation of crops strives to assist in complying with that first condition of success, by arranging the order of succession in such a way that a crop which needs much plant food in a short period of time, follows upon a crop which consumed comparatively little, but left much vegetable matter in the form of leaves, stubble and roots behind; for instance, winter and summer grains after clover and beetroots; for we know, from actual tests, that an average crop of clover or beetroots, leaves, under similar circumstances, the lands in a better condition, as far as the amount of available plant food, as well as the general physical condition of the soil, are concerned, than that of wheat or oats.

A well-devised system of rotation strives to turn the inherent soil resources, as well as the store of atmospheric

plant food, to the best account. A skilful management in this direction has, no doubt, a very important bearing on the temporary financial results of the operation; yet it cannot prevent a gradual decline and an ultimate failure, as long as local conditions of the soil and the special requirements of local markets exert a controlling influence on a proper selection of crops for rotation; and as long as more or less of the products of the lands are sold from the farm, without restoring in some suitable form the soil constituents abstracted by the articles sold off. For deep-rooting plants enrich merely the surface soil at the expense of the subsoil. Whenever that class of plants fails to find sufficient available amount of mineral plant food in the lower strata of the soil, we may rest assured the end of a remunerative production of crops is at hand. The intrinsic value of that class of plants in field and garden management rests not solely on the fact of preparing an extended area of soil for the immediate support of more shallow-rooting plants, but more emphatically on their decidedly beneficial influence on the physical condition of the entire body of agricultural soil. This influence, as we have seen, is partly due to their individual characteristics, as far as the construction of roots and leaves are concerned; partly, to the mode of cultivation they necessitate, as deep ploughing, and otherwise thorough mechanical treatment of the soil, by repeated ploughing, the liberal use of the cultivator and the hoe.

The character of the industry carried on upon the farm decides the question in regard to the quantity and the quality of the fertilizer which ought to be applied to the lands under cultivation. The intimate relation which exists in most farm managements between the cultivation of the soil and the keeping of live stock for farm labor and for the supply of food, imparts to barnyard manure a first importance for our consideration in this connection.

The name barnyard manure has rather a collective than a special meaning. Its composition depends on the character of the food consumed, the age, kind and function of the animals which contribute towards it, the nature of the material which serves for the absorption of the animal excretions, and the care bestowed upon its preparation and keeping.

Its agricultural or crop-producing value depends on its composition and on its general physical condition; its commercial value on the character of the fodder, etc., which served for its production, and on the local supply and demand.

In a well-regulated system of stock feeding it becomes the cheapest source of plant food. To adopt, therefore, a rational system of stock feeding is the first step towards securing a cheap and efficient source of home-made manure.

It is, for the same reason, but too true an assertion to be seriously questioned, that the information how to feed rationally, and thus economically, *i.e.*, to get from the fodder consumed the best returns in regard to farm labor, increase of live weight and the dairy, as circumstances may prescribe, is not less desirable for a farmer, and only secondary in importance to him, in that respect, than the knowledge how to raise his crops in an economical way.

Amount of Nitrogen, Potash and Phosphoric Acid contained in the following Fodder Articles (per ton). (Analyses by A. WOLFF.)

CROP.	NITROGEN.	POTASH.	PHOSPHORIC ACID.	VALUATION PER 2,000 LBS.
	Lbs.	Lbs.	Lbs.	
Meadow hay, . . .	31.0	32.0	8.6	$8 02
Clover hay, . . .	39.4	37.2	11.2	9 94
Potatoes (tubers), . .	6.8	11.6	3.2	2 11
Corn, ...	32.0	7.4	11.4	6 88
Beans, ...	81.6	25.8	24.2	17 69
Turnips, ...	3.6	5.8	1.6	1 10
Cotton-seed meal, . .	73.0	21.8	21.0	15 71
Cotton-seed meal cake, .	120.0	36.0	46.0	26 50
Oat straw, . . .	11.2	32.6	5.6	7 34
Wheat bran, . . .	44.8	30.6	53.8	13 13
Linseed cake, . . .	94.4	25.0	32.4	20 43
Gluten meal, . . .	97.6	1.1	9.0	18 18

In the above valuation, nitrogen is counted at 18 cents per pound; potash, 6 cents; and phosphoric acid, 6 cents.

To take care of every kind of vegetable refuse matter obtained, and to return it, with the careful exclusion of the seeds of weeds, to the soil which produced it, lessens the outlay for plant food, and benefits the continuation of the adopted industry most efficiently.

Wherever the farmer sells a portion of his produce from the farm, without restoring the essential soil constituents they contained, either by buying fodder articles for his live stock, or manurial substances which replace them, he cannot prevent his barnyard manure from changing gradually from a complete manure into a special manure for his industry; for it does not return all the essential articles of plant food needed to reproduce his crops. A change in the composition of the manure is equal to a change in the composition of the soil, in particular of that portion of it which counts in the feeding of the crops.

A liberal supply of pastures and meadow tends only to defer the recognition of these changes by transferring their own resources of fertility to those of the cultivated lands. The history of agriculture in every country teaches the same lessons in this respect.

To count, in case of an intensive farm management, to any great extent, on an efficient supply of mineral plant food, as far as the periodical wants of the plants are concerned, by means of the disintegration of the soil, has proved one of the most uncertain factors for farm calculation; and the same may be said, although with less emphasis, regarding the periodical supply of atmospheric plant food.

The recognition of these and similar circumstances led to the introduction of trade in commercial manurial substances to meet the wants made known by careful observation in the laboratory and the field.

The rapid and extensive introduction of the commercial fertilizers into the farm practice of to-day is the most striking practical acknowledgment, although quite frequently unconsciously given, on the part of the practical farmer, regarding his belief in the usefulness of scientific modes of inquiry in his field of occupation.

The concentrated commercial manurial substances furnish a convenient and efficient means of correcting the composition of our home-made manures, and to make them complete manures for the crops under cultivation.

Their special fitness for this purpose has fairly revolutionized agricultural industry. The farmer of the present finds himself more at liberty to choose his crops with reference to a remunerative market. The great value of chemical and commercial fertilizers, as *supplements* to barnyard manures and other home resources of manurial substances, is to-day universally conceded. They deserve, also, as *substitutes* in various exceptional conditions, a recommendation.

As the farmer has to deal more or less with all kinds of soil, in varying states of productiveness, he finds himself at times surrounded by serious difficulties to bring his lands into a desirable state of fertility for some paying crop, when depending on inherent soil resources of plant food and a slowly disintegrating barnyard manure. A judicious selection of some special commercial fertilizer can supply, quite frequently, the deficiency, and thereby render a certain succession of crops remunerative, which otherwise would offer no prospect of an economical success.

With these facts before us, we have to acknowledge that our difficulties in arranging an advantageous system of rotation are much lessened when compared with previous periods. We have a better chance to supplement economically our home resources of plant food in such quantity and quality as may be needed for the production of any of our farm or garden crops.

The main point which remains for us to keep in view to-day, in the arrangement of an economical system of rotation, is to secure a desirable advantageous physical condition of the soil for each crop to be cultivated.

Some crops, as potatoes, corn, and some grain crops, if well manured, can more frequently be raised upon the same lands without a serious falling off than others; as, for instance, clover and other deep-rooting leguminous plants. Winter grains prosper best on a somewhat more compact soil. Clover, root crops in general, and hoed crops, require a well-pulverized soil to do their best. A suitable mechanical

condition of the soil is evidently, in these and similar cases, of a paramount importance to a liberal manuring.

Taking this view of the subject under discussion, I conclude with a few general suggestions concerning a system of rotation: —

1. Crops of the same character ought not to be raised in close succession upon the same lands, — not grain crop after grain crop, or root crop after root crops.

2. Crops which consume large proportions of one or two kinds of mineral constituents in particular ought to be succeeded by those which require but a small quantity of them, — hoed crops after grain crops, or phosphoric acid consuming crops after largely potassa-containing plants.

3. Shallow-rooting plants should follow deep-rooting and foliaceous ones, to economize the vegetable refuse mass left behind by the latter.

4. Some kind of hoed crop should be in the course adopted, at least every four years, to assist in the destruction of obnoxious weeds and insects, as well as of parasitic growth of every description.

5. The selection of crops should be made, in a mixed farm management in particular, with reference to an ample supply of fodder crops, to enable the production of a liberal amount of home-made manure for the home industry.

6. Each crop in the adopted course should be placed in such a position as to have the full benefit of a good preparation of the soil, and a proper time for seeding.

7. Crops should also be placed in such a position to each other as to enable an advantageous distribution of the work required during the season, with reference to the resources of labor at disposal.

8. The manure, in particular the barnyard manure, should be liberally given to the hoed crops, and all those crops which necessitate a thorough mechanical preparation of the soil for their successful cultivation, to be thoroughly incorporated into the soil, and facilitate the destruction of the growth of foul seeds.

9. The entire system of cultivation and application of manure of every description should be devised with a view to benefit all parts of the producing area of the farm.

10. The industry adopted should strive to secure from the lands under cultivation the highest pecuniary returns, with a fixed determination to improve rather than to impair the productiveness of the lands engaged for its operation.

Mr. Hersey. Are there not plants which can be grown, which will gather all the potash and phosphoric acid necessary for their growth, and yet leave in the soil, available for use as plant food, more of that material than there was before?

Prof. Goessmann. The effect is ascribed to deep-rooted plants, in consequence of their forming a large amount of vegetable matter in the soil; the crop in the ground is larger than that outside the ground, and this material is left behind. Therefore we find, in the same proportion as organic matter is left behind, an accumulation of matter made available for plant food. That is one of the benefits we derive from cultivating deep-rooted plants.

Mr. Hersey. That would be the case in a forest, would it not? I suppose, in a forest, the land has more available potash and phosphoric acid than it had before the growth of the wood, has it not?

Prof. Goessmann. Wherever that growth extends for any length of time, the natural resources are made more available. Grass land is benefited more every year than land upon which we grow our grain crops. The grass land has the benefit of seven or eight months' growth, while the corn land has but three or four months. So, in proportion to the time of the growth of the crop, the land gets more benefit; its growth spreads over a more extended time. That is not a constant element, however, for this reason: Our crops which mature rapidly must have a fertile soil if they shall do their best; every article of plant food must be there in sufficient quantity to meet the utmost demand of the plant, and one of those is as essential and important as the other. Potash is one, and, to some slight extent, soda may come in, but what the effect is we do not know.

Mr. Hersey. One question more. As I understand it, you say the carbonic acid gas comes principally from the air?

Prof. GOESSMANN. Yes.

Mr. HERSEY. Now, am I not right when I say that the air contains from six to ten thousand parts of carbonic acid gas, and a richly manured soil, just after a rain, contains a little over 1,300 parts. Now, the question which I want to ask is this: Whether or not the soil, containing so large an amount of carbonic acid gas which does not rise in the air in sufficient amounts to increase materially the amount in the air directly around the plants, — whether or not that has any effect in increasing the growth of plants? We often see, after a rain or a warm spell, a heavy growth of plants, where the land has been very heavily manured. I want to ask the question whether that heavy growth is caused by the larger amount of nitrogen which is probably disengaged from the manure, or whether a portion of it may not be caused by the air being richer in carbonic acid gas?

Prof. GOESSMANN. In a sultry day, when the air is full of moisture, we have to assume, of course, that the air is of an entirely different composition from that stated in our ordinary text-books. The moisture in the air absorbs the carbonic acid and communicates it to the soil. The air is richer in carbonic acid than we generally consider it to be.

Mr. HERSEY. What amount of carbonic acid gas will plants stand before they will suffer?

Prof. GOESSMANN. I do not know exactly the proportion, but the gas is detrimental to plant life. The question, "Can plants absorb all the carbonic acid from the air?" has been settled by direct experiment. It is not by any means settled how much they may take up, under certain circumstances, by the roots. Carbonic acid is taken up by the roots, and is not essential to the plant, but a liberal supply will always benefit the crop.

Mr. HERSEY. Did I understand you that a small portion went into the leaves?

Prof. GOESSMANN. Yes, sir. It has been shown by exact observations that the leaves have a capability of absorbing carbonate of ammonia. That is a demonstrated fact, as Paschal and Ville and other demonstrators have shown. Carbonate of ammonia is, without question, absorbed by

leaves. Now, the nitrate which comes down in the rain is absorbed in the same way.

Mr. PATRICK of Boston. I am very glad the Professor has touched upon that question. I notice that most of the German and English authorities speak of the atmospheric ammonia that comes to a plant as mainly coming from moisture and dew.

Prof. GOESSMANN. That is undoubtedly true, for the very reason that a small amount of water can absorb a large amount of ammonia — seven hundred times its volume of ammonia — without giving any out.

Mr. PATRICK. Is it your opinion that the amount of ammonia absorbed in a dry atmosphere is greater than is usually supposed?

Prof. GOESSMANN. I believe that the amount of nitrogen compounds obtained by growing plants from the air is larger than represented by the observations regarding the amount of atmospheric nitrogen compounds noticed in the rain-water. Direct observations by Sachs with beans show that the upper parts of plants are capable of appropriating gaseous nitrogen compounds; and Ville's observations demonstrate that all kinds of nitrates and ammoniates may serve as nitrogen sources for growing plants. Electricity is known to produce small quantities of nitrogen compounds in the air and in air-containing water. However small this quantity may be, the fact that they are apt to be formed at any time, in an atmosphere alive with electrical phenomena, seems to me a sufficient reason for believing in a larger supply than represented by the observations with rain-water. There is apparently no basis for a definite standard by which to judge the degree of supply of nitrogen compounds from that source; not more than to assume any standard by which to determine the loss of nitrogen, in the form of nitrogen gas, in the case of decomposing nitrogen-containing organic matter. The attempt to establish a standard regarding the gain or loss of nitrogen compounds from these causes must remain for the present an arbitrary one.

One point in regard to the relation of nitrogen to plant growth seems to be generally accepted; namely, free and uncombined nitrogen contained in the air does not aid in the

production of vegetable matter in case of plants of a higher organization.

The CHAIRMAN. The time has arrived which is announced for the next lecture. I have the pleasure of introducing Mr. BENJAMIN P. WARE of Marblehead, who will speak on the subject of Corn Culture.

CORN CULTURE.

BY BENJ. P. WARE OF MARBLEHEAD.

Gentlemen of the State Board of Agriculture:

No apology is needed for again introducing the subject of corn culture to your consideration, for it is believed, at this time, to be one of the most important crops to be grown in Massachusetts, and all of the New England States. Its history is coeval with that of this country. But for the ten bushels of corn found by Capt. Miles Standish and Master Jones of the "May Flower," on landing at Cape Cod, November 13, 1620, the settlement of our Pilgrim Fathers might have been indefinitely postponed, and that of our country of a very different character from what it was.

There has been much discussion among celebrated botanists of Europe, endeavoring to settle the vexed question as to the origin of Maize or Indian Corn. Baron Humboldt says, in his essay on New Spain, that "it is no longer doubted among botanists that Maize or Turkey Wheat is a true American grain, and that the old continent received it from the new."

Charles L. Flint, in his historical essay on Indian Corn, published in Essex County Agricultural Society's Transactions, of 1849, says, after an exhaustive research: "It is a remarkable fact that maize is not mentioned by travellers who visited Asia and Africa before the discovery of America. These travellers of foreign parts were often very minute in their description of the productions of the soil; but the maize was never described in Europe until after the discovery. * * * * * This most certainly argues, very strongly, that it was not known previous to that event. There is the strongest evidence of its being indigenous to America, and that it was cultivated on this continent from time immemorial." It has ever been, and is now, an important factor in the success of this country. It was the principal food of the aborigines

of this country. It saved our Pilgrim Fathers from starvation, during their first winter's severe experience, and contributed the principal sustenance of their descendants for several generations. It formed the basis of supplies for our armies in the revolutionary war and the rebellion. It made the resumption of specie payments possible by our government. Upon it depends the vast supply of beef and pork which this country affords. For its transportation, railroads are built and steamships are kept afloat. In short, corn is king, and many nations are its subjects.

It is one of the most beautiful crops that is grown; in all of its developments of growth, from the small spear that first breaks the ground to the mature plant, it is a thing of beauty, symmetrical and majestic in its proportions.

Though a semi-tropical plant, it will readily adapt itself to the northern latitudes of the Canadas; but insists upon a portion of bright sunny weather. Yielding the largest amount of grain of any of the cereals, as well as a vastly greater amount of fodder than any of the grasses, it adds many luxuries to the table of the rich, and furnishes the staple article of food to the poor.

The corn products of this country are of such vast proportions that the human mind cannot grasp them. The estimated crop of this year is 2,000,000,000 bushels; an amount before unprecedented. We can get some idea of the value of this crop by comparing it with other products of the country. The average farm value of corn in the United States, for the last fourteen years, is $42\frac{3}{10}$ cents per bushel; and the value of the crop at that average price would amount to $846,000,000, equal to $8,000,000 of growth per day, for the 100 days required for its maturity. This sum is more than $2\frac{1}{2}$ times as great as the hay crop for 1883; three times the value of the cotton crop for 1883; twice as much as the wheat crop for the same year; more than twice as much as the combined value of the crops of rye, oats, barley, buckwheat, potatoes and tobacco grown in this country; and more than ten times the value of the products of the gold and silver mines together, of which so much account is made; yet no attempt is made by corn producers to influence Congress to enact laws to compel the people to consume more corn and less wheat, in order to

increase the price of corn, as is done by the silver kings, whose product is so diminutive in comparison with the corn crop.

Owing to the high prices of vegetables some years ago, and the ready means of transportation of corn from the West afforded by railroads, many farmers in Massachusetts were of the opinion that it was economy to buy corn rather than to raise it themselves. But if this was ever true, it is doubtful if it is now; for the same easy and rapid transportation by railroad and steamboat has brought new competition in our vegetable and fruit markets, making our products less remunerative than formerly.

Farmers have been paying from 55 to 70 cents per bushel for Western corn for the last ten years, and of a quality of much less value than of our own growth. It is believed by many of our observing farmers that our corn, ground with the cob, is fully equal in value, pound for pound, with the Western clear corn-meal. It is also believed that corn can be grown in Massachusetts for less than 30 cents per bushel, and if so, can we afford to pay double that price for corn of very much less value in quality, or be at the trouble and expense of growing other crops and marketing the same to get the money to pay this double price for Western corn? If so, farmers need never complain of their hard lives or unpaid labor.

We are aware that there are farms not naturally adapted to the corn crop and well adapted to the grass crop; or where the corn land is devoted to market gardening or small fruits, and located near large cities, that may, in such cases, be exceptions to what, as a general rule, would be profitable to a large majority of the farms in Massachusetts.

There are thousands of acres of light lands in this State, well adapted to corn growing, now yielding less than half a ton of hay per acre, that with proper treatment would yield from 50 to 70 bushels of corn, and from two to three tons of stover per acre, at small cost, with little labor, and not essentially interfering with the present system of farming, or using the manure required to keep up the grass and other crops. But to do this a different system of cultivation must be adopted than that practised by our fathers, who, follow-

ing the example set by the Indian squaws at the time of the colonial settlement, — weeding, half-hilling, and hilling, requiring much labor, that was worse than useless. A saving of labor must now be carefully studied, as labor is the great expense of the farm at the present time. The improved farm implements and machines must be used to economize labor.

Light, warm lands should be selected for the production of corn at small cost. Large fields can be cultivated to better advantage than small ones.

The time for planting cannot be better described than by the old Indian custom, which was to plant corn when oak-leaves were as large as a mouse's ear. The preparation of land should be made in season to put the seed in at that time.

Ploughing, whether in sod or old land, should be delayed as late as possible before planting; but the land should be thoroughly prepared by being well ploughed not more than six inches deep, followed by harrowing sufficiently to make a fine seed bed. Spread broadcast ten hundred weight of a reliable brand of fertilizer. This should be applied between the harrowings, reserving a small portion to be applied in the drill, or hill, with the seed. A careful observer has found by experiment that one plant of corn to a square foot of land will yield the largest crop; but as that is impractical, plant as much seed with a horse-planter as will give that average of plants when grown in rows three and a half feet apart.

The after-cultivation may be this, which involves little labor, at small cost, and is of the best quality: A few days before the corn comes up, drag the whole surface with a drag, on which a man rides and drives the horses, doing an acre in half an hour. The effect of this is to destroy the first weeds that start, and leave the surface of the land smooth, with all lumps of soil ground fine. After the corn is fairly up, go over it with a Thomas smoothing harrow, which will kill any weeds that may have started since the dragging, without injury to the corn plants. This can be done as quickly as the dragging was. Use the Thomas harrow twice more, at intervals of a week, up to when the

corn is six or eight inches high, thus keeping down the weeds, and the surface of the ground light and open. The only after-cultivation may be once or twice with a horse-hoe, or cultivator. This system of cultivation insures a field free from weeds, and in good condition for the growth of the crop, and with no hard labor.

As soon as the grain is glazed, the crop should be cut close to the ground, and stooked, by standing fifteen hills, or their equivalent, leaning against one uncut hill, in such a manner that the corn will stand alone; then by binding securely, with cheap marline or strong twine, each stook twice, they will stand against any ordinary wind, and in a reasonable time be well cured. Husking can be more rapidly done directly from the stooks in the field, or convenience may require carting to the barn before husking.

By this system of cultivation, from fifty to seventy bushels of sound corn may reasonably be expected, and from two to three tons of stover from an acre of land, and without materially interfering with the other crops, or taking from the grass lands and other crops the barn manure necessary to keep up and increase the fertility of the farm. Or four cords of manure per acre may be applied to the corn crop with about the same results as when the fertilizer is used. By this method the corn land will not increase in fertility, but would probably hold its own.

It is profitable to sow winter rye on the land, either before the crop of corn is off or immediately after, and harrow it in; or, better, plough eight inches deep before sowing the rye. By ploughing this rye in, just before planting the corn the next year, it will materially aid the following corn crop. Corn may be successfully grown in this way for years in succession on the same land.

There is plenty of evidence to prove that the amount of crop may be grown as stated above. Dr. E. Lewis Sturtevant grew, on a nine and a half acre lot, of poor, run-out plain land, that would not yield one half-ton of hay per acre, with fertilizer alone, an average of $60\frac{3}{10}$ bushels per acre, for four years in succession, and he claims to have grown, by weight, four tons of stover per acre; which, however, is much above the average amount of stover for this growth of

corn. James J. H. Gregory raised, on a poor, worn-out pasture, over 70 bushels corn per acre, with fertilizer alone. I have grown 70 bushels on light land, with nothing but fertilizer. Many other instances might be cited, did time permit.

In arriving at just conclusions as to the cost of raising a bushel of corn in Massachusetts, the value of the stover becomes an important factor in the calculation. Gov. Boutwell has carefully experimented on his farm, and finds that good corn stover is worth as much as good English hay, for making milk. The same results have been found by several experiments in Essex County. Benjamin Walker of Worcester fed eighteen heavy horses, when at work in ice-wagons, thirty-four days, on cut corn stover, and reduced the amount of grain fed one-third from the amount previously given with hay, and they gained 160 pounds in the aggregate during the thirty-four days of the experiment. Mr. E. F. Chamberlain of Worcester, a very careful observer, after forty years of experience in feeding milch cows, declares that corn stover will produce as much beef, milk and butter as the very best of hay, ton for ton. Dr. George H. Cook, of New Jersey Experiment Station, has recently shown by analysis that a large portion of cornstalks, which are generally wasted in the barnyard, are fully as nutritious as clover hay; and that by cutting up the stalks, and feeding it mixed with the same amount of meal or shorts, the cow will do just as well, and give as much milk, as if fed on hay. So it is thus proved that corn stover is equal in value with hay for producing milk and beef, and of more value for producing muscle for work. Now, if these premises are correct, as appears, why is it not fair to reckon the value of stover the same as hay on the farm, which will average about \$20 per ton? But to make assurance doubly sure, and to satisfy some doubting Thomas, we will discount it 25 per cent., and in our calculation call its value \$15 per ton. According to 116 trials reported in former volumes of the reports of this State Board of Agriculture, it is shown that, by an average of these trials, for 72 pounds of ears, allowed for 1 bushel of shelled corn, there would be $80\frac{8}{10}$ pounds of

cured stover; hence, for a crop of 50 bushels of shelled corn per acre, there would be 4,040 pounds of stover.

The cost of producing one acre of corn upon this basis is about as follows: —

Ploughing,	$2 00
Harrowing twice, at 50 cents,	1 00
Planting,	1 00
Seed,	50
Dragging,	50
Harrowing with Thomas' smoothing harrow three times, at 50 cents,	1 50
Cultivating with horse three times,	1 50
Cutting and stooking,	3 00
Twine,	25
Husking,	5 00
Carting,	1 50
Interest and taxes,	4 00
Half-ton fertilizer,	22 50
Total cost,	$44 25

Value of 2 tons of stover, calculated on a crop of 50 bushels ($15), $30. Cost of corn, $14.25, which is at the rate of $28\frac{3}{5}$ cents per bushel.

A crop of 60 bushels per acre would yield 4,848 pounds of stover. Additional cost of handling increased crop, $1.95. Valued at $36.36. Cost of corn, $9.76, or at the rate of $16\frac{2}{10}$ cents per bushel.

A crop of 70 bushels per acre would yield 5,656 pounds of stover. Additional cost of handling the increased crop, $3.90. Valued at $42.42. Cost of corn, $4.90, or at the rate of 7 cents per bushel.

Of the 150 or 200 distinct varieties, I would recommend, as best for general cultivation, the Longfellow corn. This variety was developed by Joseph Longfellow, one of our most intelligent farmers, of Byfield, in Newbury, Essex County, by careful selection for more than thirty years. You will observe that it has a very long, slim ear, eight rows, a small cob, and is small at the butt, on account of which it is easier to husk and less liable to mould in a late season. It produces a medium growth of stover, early enough to ripen well in ordinary seasons; will adapt itself to high or low culture, yielding crops in proportion to its cultivation.

There are many other excellent varieties, with characteristics that might meet some wants of different persons or localities possibly better than that.

I do not propose to consider the advantage to be gained, if any, in the quality of the corn crop, by the process of preserving by ensilage over that by drying, but simply the economy of labor, in reducing the cost of handling the crop. It has been found, by an accurate account of labor, that there is a saving of more than five dollars per acre by cutting it green into the silo, over that of preparing it, in same condition for feeding, after being cured in stooks. This may be done to advantage by picking all good ears at the same time as for stooking, and throw four rows of ears into one on the ground. The imperfect ears had better be left on the stalks; then the stalks may be cut close to the ground and carted to the silo. The ears will cure perfectly in this way, and are very convenient for husking. I would also call your attention to saving the cost of husking and grinding by cutting the whole crop, ears and all, into the silo at the time of the grain being glazed. By this method a saving of at least $15 per acre may be gained in preparing the crop for feeding. I shall be prepared, after this year's experience, to state whether there is any chemical loss in nutriment by this process over that of drying and grinding.

This subject would be very incomplete without alluding to the value and importance of sweet corn. The establishment of canning houses in different localities has opened a new and profitable business for farmers wherever they are situated, the sum paid for the green corn being quite remunerative; and the stover of sweet corn is even more valuable than that of flint corn. A visible proof of this was made by J. E. Page of Salem, who came to a section of ensilage from sweet corn, composed of stocks after the ears had been picked for the market, and his stock of forty milch cows decreased in their milk seventy quarts per day after returning to the feed on common corn ensilage.

Sweet corn, of a suitable age, when picked fresh, and properly placed upon the table, is certainly one of the greatest luxuries of the season, and no farmer's table should be without it during its season. It is not only delicious, but

very nutritious, and no food can be furnished at less cost; and farmers can enjoy this luxury as our city cousins cannot, for sweet corn, at its best, should be cooked soon after being picked. City tables are not usually supplied until the second or third day after picking, when it has lost much of its delicacy of flavor.

The season for sweet corn can be prolonged from the 25th of July until heavy frosts, by frequent planting, or, better, by planting several varieties at once, which require more or less time to mature. If farmers depend upon planting at different times, it is very apt to be neglected, leaving a disagreeable gap in the supply, besides requiring more time and labor to prepare the land in small lots for planting.

The following varieties, which are all of excellent quality, may be planted together, and will follow each other for the table very closely: first, the Early Marblehead; then the Crosby's Early is ready, as soon as the other becomes too old; then, Early Amber Cream; next, Egyptian; and then, Stowell's Evergreen Sweet. These varieties will keep up a very close connection for the season.

Now, I want to say a word in regard to what has been presented to us in so able a manner with reference to the rotation of crops. While this system of cultivation may be followed year after year on the same land, in growing corn by this system, successfully, yet it does not by any means follow that the system of rotation of crops is not a valuable one. It certainly is a very important one. But very many lands that we have in Massachusetts, adapted to this peculiar kind of corn culture, are of such character that they are not adapted to rotation so well. For instance, they would never yield a heavy grass crop; they would not be so valuable for growing many root crops that I have mentioned. This fact, that corn can be grown by this system on the same land year after year, with the introduction of a crop of rye occasionally, and ploughing it in, is a very important one. It has a chemical effect, provides humus for the land, and is very desirable.

If farmers will take Dr. Goessmann's tables, and experiment on their land according to the system recommended

and adopted by Prof. Atwater of Connecticut, and learn the wants of their fields, they may save the expense of buying materials that they do not need, or they may find it necessary, as the most economical method, to add a greater proportion of one of the ingredients of plant food than the proportion that is generally given us in the prepared article. I suppose you are all aware that when we buy a fertilizer, properly prepared and properly presented to us, we pay a profit of about 33 per cent. over what it would cost us if we bought the raw materials and mixed them ourselves. I do not complain of that. Many of us are not in a condition to buy the raw materials and manufacture our fertilizers ourselves; but if we buy them in the proportions indicated by the wants of our crops, by the tables that we have had presented here, and by the wants of our fields as we can ascertain them by the method I have indicated, we can save a large percentage in the cost of producing corn, and I am not sure that we might not get it down so that the forage would pay all cost. I will leave it to you to say if that is not a fair statement. If it has been proved that corn stover, well cured, will produce as much milk, beef and muscle for work as English hay, is it not fair to reckon it the same in value? And when English hay is worth on an average about twenty dollars a ton on our farms, if we feed that hay to our cows we are feeding an article that we can get that amount of money for; and if we feed corn stover as a substitute for hay and get the same results, why are we not receiving twenty dollars a ton for it, the same as we should if we used the hay? I am well aware that many will criticise this method of reckoning the cost of corn, but I can see no fallacy in it. It seems to me a legitimate way of getting at the cost.

Mr. EDSON of Barnstable. I noticed that the gentleman stated that corn should be planted at a distance of about three and a half feet. My experience has been that I must make the distance according to the variety of corn that I wish to raise; that to raise the early Canada corn, which has a very small ear, — which I consider one of the best varieties, — I must plant it about three and a half feet apart.

If I plant a variety which produces a large ear I must have the hills four feet apart, because the stover grows so much higher and shades the corn. You cannot get a good crop of corn if the ground is too much shaded.

As to rotation of crops, I will say that on my farm the principal crop from which I get my money is hay. About once in four or five years I break up my land; it gets foul stuff in it, and I want good hay. My plan is, having about four or five pieces in grass, with from three to four acres each, I break up one every four or five years. I haul manure upon that grass land in the winter and let it soak into the sod thoroughly. I delay ploughing just as long as I can, say until about the last of May, and, if it is good mowing land, I have then about as much grass as I can turn under. The manure has soaked into the sod, ready to receive the roots of the corn when it first starts, and I expect to get, in a good year, from 60 to 70 bushels of shelled corn to the acre. I can plant a great many more hills of that small corn than of the larger varieties, and it produces a greater number of ears. There will be two or three ears on a stalk, — more often three than two, — while the large corn will produce but one good ear. So I can get, I think, more bushels of small corn to the acre than I can of the large, and the stover is much better. My plan is to plant corn two years in succession. When the corn is taken off I put in winter rye; in the spring I put manure on the rye, and about the last of May that rye will be up high enough to be turned under. Now, the advantage of corn in rotation is this, that you can get a green crop each year to plough under with your manure. You cannot do that with other crops. The difficulty with potatoes is, that you have got to plant your potatoes so early in the season that if you sow rye on the land it does not amount to anything. When you turn your rye under, you have got a large amount of green matter in the soil and you will get a good crop of corn. Next year, your land is thoroughly cultivated, the foul stuff is out; you seed that down, and for the next three or four years you will get from two to three tons of good hay to the acre. I think Mr. Ware has put

the price of cultivating a little low; it certainly would be in my case. I find it necessary not only to run the smoother over the top, but I find it necessary to use the cultivator and the hoe. I cannot keep the dog grass down unless I do. I plant in hills and go both ways with the cultivator, and then I find that it is necessary to hoe it a little afterwards.

QUESTION. Have you made any careful experiments as to the value of stover as compared with hay?

Mr. EDSON. I have not. I have estimated the value at about one-half that of English hay. That is the idea that I have of it. Cattle will not eat it all; there is some waste. Good English hay is eaten up clean; corn stover is not. It might be, if put into a silo; probably they would eat it all then. I do not think corn stover is worth more than half as much as English hay.

QUESTION. Because the cattle eat only half of it?

Mr. EDSON. Because they don't eat the whole of it.

Mr. SESSIONS. I agree that the amount of corn stover that cows will eat is worth as much as English hay. Experience shows me that they will eat only half the corn stover, but the half they will eat is worth as much as English hay. So I divide the value of English hay by two and get at the value of corn stover, or pretty near it. Then it is to be considered that it is more trouble to handle it and stow it, so I reduce the one-half ten per cent.; and when I have reduced the value of English hay fifty per cent., with ten per cent. more, I think I have got just about what corn stover is worth.

Adjourned to two o'clock.

Afternoon Session.

The meeting was called to order at two o'clock by Mr. Bird, who introduced as the first lecturer, Prof. J. A. Lintner, State Entomologist of New York.

ON SOME OF THE INJURIOUS INSECTS OF MASSACHUSETTS.

BY PROF. J. A. LINTNER OF NEW YORK.

Gentlemen, — Before proceeding to discharge the pleasant duty that I have undertaken in compliance with the kind request that you, through your Secretary, have done me the the honor of making, — that I would give you some practical remarks upon insects with which you have to contend in your farming operations, — will you please allow me a few preliminary words.

Always glad, as I am, of an opportunity to commend the importance of the study of economic entomology, and to give some evidence of what it has accomplished, it is with more than ordinary pleasure that I am permitted to address the Massachusetts State Board of Agriculture. Not because I have been assured that I would find an appreciative audience, but that I can avail myself of the occasion to make public acknowledgment of the debt of gratitude that American agriculture owes to you, to those who have preceded you, and to your State, for what you have done in the promotion of economic entomology.

Here in Massachusetts the science had its birth, and to the fostering care that it has continued to receive we are largely indebted for the proud position that it at present holds.

Nearly a century ago — in the year 1793 — a prize was offered by the Massachusetts Society for Promoting Agriculture, for the best essay to be presented to it upon the "canker-worm," — an insect which, according to a statement made in the "New England Farmer" in 1790, had at that time been a destructive pest in many portions of New England for fifty years. The prize was awarded by the Society to William Dandridge Peck, for his paper entitled the

"Natural History of the Canker-Worm," published in the year 1795. The paper was worthy of being a pioneer in a new line of investigation.

Mr. Peck's studies upon the canker-worm were made at Kittery, Maine, but he was subsequently called to Harvard College. In 1817, another paper, "On the Insects which destroy the young Branches of the Pear-Tree, and the leading shoot of the Weymouth-Pine, by W. D. Peck, Esq., Professor of Natural History and Botany, at Harvard University" (I cite from the paper in my library), was published in the "Massachusetts Agricultural Journal" (January, 1817, vol. iv., pp. 205–211), by the Society before mentioned.

The lectures of Professor Peck were attended by Thaddeus William Harris of Dorchester, Mass., during the years 1813–15. Of his instructor, Dr. Harris, in his later years, wrote: "It was this early and much esteemed friend who first developed my taste for entomology, and stimulated me to cultivate it."

I need not dwell at length upon the entomological labors of Dr. Harris, for they are familiar to you all. To him, perhaps more than to any other man, do we owe the wide-spread interest felt in the study of the insect world. His collection of insects was commenced in or about the year 1820, at the time when he entered upon the practice of his profession at Milton; and during his residence here and at Dorchester most of his out-door researches were made. His studies were untiringly continued for the remainder of his life, during the long period of twenty-five years that he held the librarianship at Harvard University, subsequent to the year 1831.

At the commencement of his librarianship he was honored with the preparation of a catalogue of the insects of Massachusetts, which was appended to the geological report of the State by Professor Hitchcock. Ten years later, in 1841, was published his "Report on Insects Injurious to Vegetation," one of the scientific reports which were prepared by the Commissioners on the Zoölogical and Botanical Survey of Massachusetts, agreeably to an order of the General Court, and at the expense of the State. It has the honor of

being the first government publication on insects issued in the United States. Subsequent editions have appeared of this report, with additions in 1852 and again in 1862, — the latter with illustrations. Of this work it may justly be said the State has honored itself in its publication. Although so many years, marked with wonderful progress, have elapsed since its preparation, it is still the first volume that I recommend to those who desire to learn of insects and their habits; for it stands to-day as fresh, as interesting, as valuable as when first issued from the press, — unsurpassed, we believe, by any similar report in any other department of natural history ever published.

Your own Board has done much to encourage entomological studies. I have in my possession a paper entitled "Economic Entomology, by Francis G. Sanborn, Entomologist to the Massachusetts Board of Agriculture," without date of issue, but probably published about the year 1860.

"An Essay on some of the Insects of Massachusetts which are Beneficial to Vegetation," by the same author, as entomologist to the Board, and forming a portion of the report of your Secretary for the year 1863, is a valuable contribution, treating of insects in their several orders, and illustrating them in sixty figures.

In the years 1871, 1872 and 1873, three valuable reports were made to your Board by Dr. A. S. Packard, Jr., upon the "Injurious and Beneficial Insects of the State of Massachusetts." So able were these reports and of so great practical importance to agricultural interests, that it is much to be regretted that provision could not have been made for a continuation of the series.

There are, doubtless, among the publications of your Board, other contributions to the science, to which reference deserves to be made, of which I have no present knowledge.

In this connection it is proper that I should refer to a collection in economic entomology that within the last few years has been quietly brought together and built up at the Museum of Comparative Zoölogy, at Cambridge, by the distinguished professor of entomology, Dr. H. A. Hagen, under the fostering care of Alexander Agassiz. It has for its object a

better opportunity of acquaintance with the insect world than can be afforded by the study alone of books. To this end there have been arranged, in convenient cases, in connection with each insect shown, its several stages of the egg, the larva at different periods of its life, and the pupa; its architecture, in its cocoons, nests, burrows, etc.; its various food-plants, showing methods of attack and injury; diseased conditions resulting from fungoid and other attacks, or from causes producing monstrosities and deformities; the several parasites that prey upon it — in short, whatever may serve to illustrate its entire natural history. So rich has this collection already become, in its five thousand species more or less fully illustrated, that I give it but the praise that it deserves when I say that it has not its equal in any other collection of the kind in the world.

Nor should I omit passing reference to the good that has resulted from the Entomological Department of the Cambridge Museum, in that the study of its collections and the instruction of its professor have largely influenced the habits of thought and paths of labor of several students who are now successful teachers of entomology in our colleges and universities.

I cannot now refer to the many notable contributions made by the members of your scientific bodies and others to general entomology, in the extensive collections gathered, in the new forms described, the life-histories given, the anatomical and histological investigations pursued, the classificatory work done. Not alone are these lines of study, one and all, of great importance in themselves, and their pursuit ennobling, — for the humblest insect that lives is richly worthy of the attention of the highest intellect, — but further, each one of you, each member of community, has direct interest in such labor, indispensable as it is to a proper knowledge of the insect world, with which we are brought into such intimate and dependent relations, in our cultivation of the soil, within our homes, and everywhere.

Without occupying more of the time allotted to me in referring to several other topics of which I would love to speak to you, I will pass on to meet the purpose of my invitation hither.

But how could I discharge the duty of even a brief discussion of the numerous insect pests which with each returning year force themselves upon you, and compel battle with them if you would not permit them to wrest from you often the entire results of a season's toil? Fortunately your Secretary has kindly extricated me from this dilemma, in suggesting to me a few insects upon which a desire has been expressed, by several of your number, for information that will prove serviceable in arresting widespread and serious depredations.

I will ask your attention, first, to a class of insects which — although occurring abundantly in almost every portion of our country, everywhere occasioning serious losses, and although volumes have been written of them — are yet very imperfectly known by those who are suffering from their depredations.

Cut-Worms.

Before we can contend successfully with our insect foes, it is necessary to know who and what they are. There is no universal panacea for insect injuries. The natural history and habits of each species requires separate study, and not until we have become acquainted with all the conditions of their existence are we prepared to make recommendation of the best means to be employed against them. So varied are these conditions, even among the members, often, of the same genus, that a remedy that will be efficient with one will be powerless against another. The bearing of these remarks will be evident when we state that, not unfrequently, a reported "cut-worm" attack proves, upon examination, to be that of quite a different insect, — perhaps that of the "white grub" or some allied coleopterous larva, — of one of the many species of "wire-worms," the larvæ of our "snapping-beetles,"— or it may be of a "thousand-legged worm," which does not even belong to the class of insects. The nature of the injury committed by these several forms is much the same: roots are eaten, or stalks and blades are cut off, and it is *believed* to be caused by a cut-worm. Surely, guessing at the cause of an injury is

incompatible with scientific treatment for its arrest. Whenever, therefore, any unknown form of insect attack presents itself to the farmer, the gardener, the horticulturist, the florist, — let him first learn the particular depredator he has to deal with, and then seek the best remedy, either from books authoritative upon the subject, or from some one prepared and competent to give advice.

If the study of our common insects had that place in our public schools and other institutions of learning that its practical importance entitles it to, the labor of the economic entomologist of the present day would be lightened, and much of what may be regarded as preliminary instruction would be spared him. It should not be necessary in a paper like the present to tell what a "cut-worm" is, yet if I give its principal features, and those of the winged form into which it develops, I think that I shall be imparting serviceable and acceptable information to some.

What are Cut-worms? — Cut-worms are the caterpillars of an extensive family of moths known by the name of *Noctuidæ*, from their coming abroad for flight chiefly during the night; the moths (nocturnal) united with the butterflies (diurnal) forming the order of LEPIDOPTERA, so named from the myriads of small scales which, in symmetrical arrangement like the shingles or tiles of a roof, cover and color both the upper and lower surfaces of the membranous and veined transparent wings.

There are many distinct species of cut-worms, but we cannot give even their approximate number. Most of them belong to three genera of the *Noctuidæ;* viz., *Agrotis*, *Mamestra*, and *Hadena*, of which about three hundred and fifty United States species have been described. Some of these are known not to possess true cut-worm habits, but of much the larger number the caterpillar stage remains unknown.

The following are the principal cut-worm features possessed in common by nearly all the species, and which should suffice for their recognition. When full grown, they measure from an inch and a quarter to nearly two inches in length. They have sixteen feet, of which the three anterior pairs (true legs) are pointed, and the five remaining pairs (prolegs), stout, blunt, and armed with minute hooks for clasp-

ing. In form they are stout, tapering slightly at the extremities. In appearance they are usually dull-colored, greasy-looking, dingy-brown, gray or greenish, with some light and dark longitudinal lines, and sometimes with oblique dashes. They have a large, shining, red or reddish-brown head. The first ring, or collar, bears a darker-colored, shining, horny plate, as does also the last one, known as the anal plate. The body is never hairy, but the several rings have upon each six or eight small, blackish dots or humps, from each of which a short hair is given out.

Their Habits. — It is the habit of the cut-worm to pass the day in rest, hidden in a hole made in the ground beside its food-plant or among its roots, or in concealment beneath stones, sticks, rails, or other convenient shelter. The night is the season of their activity, when they seek their food. Some of them feed only beneath the surface of the ground upon the roots of plants; others thrust their body in part from their burrow and cut off the blade, which they take with them into the ground to feed upon at their leisure; while others come abroad and make vigorous attack upon the young annual plants of the garden or the field, feeding upon their tender tips or severing the stalks. If search be made for them at night-time with a lantern, they may often be found by hundreds busily engaged in their destructive work. At the approach of day they again seek their hiding-places, often in the hole made near the plant. When taken from the ground or disturbed in their shelter, they usually curl themselves up in a ring.

A few of the moths may be seen by day, feeding upon the nectar of flowers, as of the golden-rod (*Solidago*) and some others; but nearly all of them pass the day in sleep in various hiding-places, such as under the bark of trees, in piles of wood or stone, in crevices of walls, behind closed window-blinds, or in any convenient dark, secluded retreat. They are generally of obscure colors, in some shade of brown. When in repose, their wings are folded almost parallel to the surface upon which they rest, and in line with their body, giving them an elongated form. The wings are thick, smooth, often shining, and marked with characteristic lines and spots which are usually not very conspicuous.

Natural History. — The eggs that produce the cut-worms are usually deposited by the moth upon some low plant convenient to the food that is destined to nourish them. Sometimes, however, as in *Agrotis saucia,* they are placed in long, narrow patches upon small twigs of apple, peach, and other fruit trees, quite removed from the natural larval food The general time of their deposit is in the latter part of summer. Hatching in a short time, the larvæ enter the ground and commence to feed upon the young roots of various p'ants. With the cold of winter, they cease feeding, and bury deeper in the ground, where they shape for themselves an oval cavity in which to pass the winter in a torpid state. In this condition, if undisturbed, freezing fails to harm them. In the early spring they resume their activity, make their way toward the surface, and commence their feeding upon the starting vegetation.

Within a few weeks they become full grown, when they again bury in the ground, where they mould a cell, or earthen cocoon, in which to undergo their transformation to the pupal state. Two or three weeks are required for this stage, when the moth issues from the rent pupal case, and makes its appearance above ground. The wings, at first small and contracted, are soon expanded, and the insect has reached its perfect stage. The sexes meet, eggs are deposited for another brood, a little food is partaken of, consisting of the nectar of flowers or other sweets, and within two or three weeks, ordinarily, if not sooner terminated by their many enemies, the life-cycle is completed. In some instances a second brood follows during the summer and autumn, but with most of the species the life-history is as above given. Occasionally the hibernation is in the pupal stage.

Food-Plants. — Many of our injurious insects confine their depredations to a single food-plant, or to the members of the same genus, or to closely allied plants. The cut-worm, unfortunately, is more indiscriminate in its taste; and although certain species show a decided preference for some particular food-plant, yet, if this is not convenient, other substitutes are readily accepted. When we add to this the varied tastes of a large number of species, it ceases to be

a surprise that so many of the products of our fields and gardens suffer from their aggression.

Their injury to *grass* is far more serious than is supposed. It is believed that the first half of the active life of many of the species is passed in feeding upon the roots of grasses, and that they only assume the true cut-worm habits when approaching maturity demands stronger and more abundant food. Usually their presence in grass lands is unnoticed, or if an impaired growth is observed, it is ascribed to other causes. But at times, for reasons unknown, they multiply to such an extent that we may no longer be blind to their ravages; as in the visitation of the bronze-colored cut-worm. *Nephelodes violans* (Guenée), in 1881, in the northern counties of the State of New York, when the pastures and meadows suffered largely from their attack; and of the black-lined cut-worm, *Agrotis fennica* (Tausch.), in Michigan, last year, when, as represented to me by Professor Cook of the State Agricultural College, there were meadows through which one could not walk without crushing from a dozen to a hundred at each step.

Corn is known to be a favorite food-plant of many species, of which we recognize twelve by name — the two more common ones being *Agrotis clandestina* and *Hadena devastatrix*. Experience has taught every farmer that a cornfield upon a newly turned sod is a luxurious home for the cut-worm, where they particularly abound. It is stated that sixty have been taken from a single hill of corn.

Wheat and *barley* occasionally suffer from their attack, but we are thus far favored by not having had introduced among us, with the scores of imported pests brought by commerce to our shores, the wheat dart-moth, *Agrotis tritici*, or the common dart-moth, *Agrotis segetum*, which cause such enormous losses to the European wheatfields. None of our species are nearly so destructive to this staple crop.

Entire settings of young *cabbage plants* are often destroyed by them. In one plot of six hundred plants, only thirty escaped. The owner killed about two hundred of the worms on the first day of their appearance, and five hundred or more on the following day, after which the ground was reset with late cabbages. Of the species known

to prey upon cabbage, are *Agrotis clandestina*, *Agrotis saucia*, *Agrotis annexa*, *Mamestra subjuncta*, *Mamestra trifolii* and *Hadena devastatrix*.

Turnips are liable to attack by being eaten into around the neck of the plant until it is detached, or by its separate leaves being cut off and drawn into holes beside the plant.

To *onions* they are at times so destructive as to ruin entire crops. In one field of four acres in Chatauqua Co., N. Y., upon which onions had been grown for sixty years, the worms were dug out and killed in almost incredible numbers — to the amount of "bushels," in some years, it is stated.

A remarkable attack was made upon onions, in Goshen, Orange Co., N. Y., the present year, where several hundreds of acres of drained swamp land are devoted to their culture. The worms appeared in myriads, in June, as soon as the onions had started; first eating them from their tips downward, but later developing the true cut-worm habit in severing the stalks. The species was believed to be *Agrotis malefida*, a southern form, not hitherto noticed injuriously so far north.

The tender stems of young *beans* furnish tempting food, and every one who has grown them knows the frequency with which they are found, in the morning, with severed stems, showing the operation of the cut-worm.

In portions of Canada, *clover* suffered severely from a formidable attack of a caterpillar which was thought, at first, to be the army worm, but which, upon rearing the moth, proved to be one of the cut-worms, *Agrotis fennica*.

Tobacco plants are often cut off in the month of June. In West Meriden, Conn., from one row of one hundred and eighty plants, two hundred and fourteen of the worms were taken and killed.

They frequently attack and destroy *flowering plants* in our gardens, as hyacinths, pansies, carnations, nasturtiums, phlox, asters, balsams, and many others.

Among other garden and field crops to which they are destructive, may be mentioned peas, beets, potatoes, tomatoes, pumpkins, melons and squashes.

Natural Enemies. — The large size of the cut-worms, their hairless bodies, and no provision for protection except their concealment by day, render them attractive and an easy prey to their many enemies, who persistently seek them for food, and by the large numbers that they devour greatly mitigate the injuries that their unchecked increase would otherwise cause. Several of our common birds render effective service in this direction. Foremost among these is the robin, of which it has been said: "Its eminently terrestrial habits, its fondness for larvæ of various kinds, and its ability to obtain those that are hidden beneath the turf, give it a usefulness in destroying cut-worms which no other bird possesses in the same degree, and for this feature in its economy alone, its greater abundance should be encouraged. Early in the morning, and toward the close of the evening, the robin may often be seen searching for cut-worms in lawns, pastures and meadows, and when thus engaged it hops about, gazing apparently more at distant objects than searching for something near at hand; then, suddenly, it commences tearing up the old grass and turf with its bill, and, in another instant, it stands triumphant with its wriggling prize in its bill, for it rarely digs in vain. I have seen a robin capture, in this manner, five cut-worms in less than ten minutes, and five other birds within view were doing the same work."

Other birds that are known to prey upon cut-worms are the cat-bird (*Mimus Carolinensis*, L.); the red-winged blackbird (*Agelœus Phœniceus*, L.); and the purple grackle (*Quiscalus purpureus*).

Poultry, and especially chickens, are efficient destroyers of them in gardens in the spring, when they scan closely the upturned ground, and are quick to detect and devour them.

Among the members of their own class that feed upon them, is the larva of a ground-beetle, known as *Calosoma calidum* (Fabr.). It is so destructive to them, and attacks them with so much energy, even if the worm be twice its size, that it has been designated as the "cut-worm lion."

The larva of another beetle, *Harpalus caliginosus* (Fabr.), is also its persistent enemy; and from its ferocity in seizing its prey, and its strange, irregular form, it has been called

the "cut-worm's dragon." Dr. Fitch has written of it: "When not glutted with food, it is running about incessantly in search of these worms, and slays them without mercy; with its powerful jaws seizing them commonly by the throat, and, regardless of their violent writhings and contortions, sucking out the contents of their skins." Others of the same family of beetles, the *Carabidæ*, also feed largely upon them.

One of the HEMIPTERA, which preys upon quite a number of other species of insects, and which from its belligerent propensities has received for its common name that of the "spined soldier-bug," and is known in science as *Podisus spinosus* (Dallas), will fearlessly attack a young cut-worm much exceeding it in size, and piercing it with its formidable beak, extract its juices from it, leaving only its shrivelled skin.

The toad deserves introduction, shelter, and protection in our gardens, from its coming abroad at night during the period of activity of the cut-worms, and contributing largely to the diminution of their numbers.

Parasites. — The quiet and concealment in which these nocturnal marauders of our gardens and fields pass their time during the hours when most of the parasitic insects are upon the wing, in ceaseless search for their victims, into which they can thrust their ovipositor and insert the fatal egg, give them a large degree of immunity from parasitic attack. Yet as even the "white grub," which never appears above ground, is sought out in its subterranean retreat by its parasite *Tiphia inornata*, so even these are far from enjoying immunity. The bronze-colored cut-worm before referred to, in my attempts to rear it, has proved to be quite liable to be parasitized by one or more species of a Tachina fly. A species of *Microgaster*, *Apanteles militaris* (Walsh), and an *Ophion* has also been obtained from it. Other parasites reared from other larvæ are *Paniscus geminatus* (Say), a large yellowish-brown ichneumon fly; *Nemoræa leucaniæ* (Kirkp.); *Tachina archippivora* (Riley); and *Scopolia sequax* (Williston), — three species of Tachina flies.

Preventives and Remedies. — The measures recommended for preventing or arresting cut-worm ravages have been exceedingly numerous, and perhaps each one might claim a degree of value under certain conditions, but at the present only those from which the best results have been obtained will be referred to.

When grass is infested, as in lawns, it is difficult to control the attack. Perhaps gas-lime, where it can be obtained, applied at the commencement of winter, would penetrate to a sufficient depth to kill the larvæ. Usually it will be found necessary to sacrifice the sod. It is claimed that where land is not allowed to lie in sod for over two years at a time, the worms will not accumulate in it. Removing their food is an effective method. This may be done by turning over the grass before it has made much growth in the spring, and dragging, to bring up the roots to the surface for drying. A week later, another thorough dragging will destroy all green vegetation. Late ploughing, in the autumn, is said to be an effectual remedy, if deferred until the cut-worms have become torpid, and the ploughing sufficiently deep to crush the cells that they shape for their winter's sleep.

Two preventives of attack to cornfields have been given, which, from the testimony borne to their efficacy, may be accepted as reliable. The first is the simple and easy application of *salt*, as follows: Immediately after the corn is planted, sprinkle on the hill, over the covered grains, about one tablespoonful of common salt to each hill. The explanation given for the protection of the plants is, that as the salt dissolves and is carried to the roots and taken up into the circulation, the young corn becomes unpalatable to the worms, and they will not eat it, while the direct application of salt to them is harmless, even if they be buried in it.

The second method, which had been tested by the gentleman recommending it and by others for twelve years, and always with success, even upon new ground and clover land, is soaking the corn before planting in *copperas water*. Tests had been made by planting portions of a field without the preparation, and these portions in several instances required replanting two or three times. The manner of preparing the corn is as follows:

Put the seed-corn in a tight tub or barrel, and pour in enough water to keep it well covered after it swells. For each bushel of corn add a pound or a pound and a half of copperas dissolved in warm water. Stir well, and allow the corn to remain in the copperas water twenty-four or thirty hours. Stir several times while soaking. Then take it out and sprinkle a small quantity of land-plaster over it, — enough to prevent the grain from sticking together, — and plant. When prepared as directed, if a change should occur in the weather to prevent planting, the corn may be spread out upon a floor and allowed to remain until good planting weather.

As a test of the efficacy of the above preventive, a forty-four-acre field of corn was planted, — first, ten acres without the copperas preparation; next to it, nearly ten acres with the prepared seed; and the remainder with unprepared: otherwise, all treated alike. As the result, *not a hill was cut or a worm was found where the copperas had been used;* while the entire field elsewhere was cut, from two to three hills out of five, with sometimes fifteen cut-worms in a hill.

There is a prejudice against the *digging-out-by-hand* method, as requiring too much valuable time and labor, and therefore not available where large fields are to be protected; yet it is one of the best means to be employed against this pest, unless the poisoning method recently recommended, and next to be referred to, shall be found to give easier protection.

Many of our preventives merely drive away the hungry creatures to attack and destroy other and perhaps more valuable crops; but with a cut-worm dug out from its hiding-place beside a wilted plant and killed, there is the satisfaction, not only that its possibility for further harm is ended, but that it will not develop into a moth, the following season, which may deposit two hundred eggs, each of which will produce a cut-worm.

Mr. Armstrong, secretary of the Elmira Farmers' Club, has stated: "There is really but one way to save the crop after the plants are once attacked by cut-worms; that is, to dig the worms out and kill them. It is not a difficult task, nor is it very costly. I presume that a fourth part of the

loss sustained would be a full equivalent of all the labor it would cost. The worm does the mischief at night, and before morning burrows in the ground near the spot where its depredations have been committed. A practised eye will readily discern the entrance to the hiding-place into which the worm has passed and lies concealed. The way to bring the pest up is to thrust a pointed knife down near the hole, and lift out the earth to the depth of two or three inches, when the malefactor will lie exposed to view, and can be instantly destroyed. I have known large fields to be cleared by this process, at a cost of labor so slight as to bear no comparison with the loss that would have otherwise resulted."

The practicability of this method, and an idea of the expense attending it, will appear from a statement made by a correspondent of the "Country Gentleman." A six-acre field of corn, planted on sod turned over from a pasture before planting, showed a strong attack of cut-worms. Two men were employed to dig them out. Taking a row at a time, and digging down wherever a plant was cut, they went over the field in half a day, killing over fifteen hundred. A few days later they went over it again, not getting as many; and again, for a third time. Without this labor, it was thought that one-half of the crop would have been lost. The three days' work was worth four dollars, and at least one hundred bushels of corn were saved by it.

The poisoning method referred to is the use of a *bait of leaves or clover*, of which the worms are fond, *poisoned with Paris green*. Professor Riley, in his last report as entomologist of the United States Department of Agriculture, has recommended clover sprinkled with Paris-green water, and laid at intervals between the rows, in loosely tied masses or balls, which serves the double purpose of prolonging the freshness of the bait, and of affording a lure for shelter.

A modification of the method, employed by Dr. Oemler of Savannah, Ga., was that of preparing cabbage or turnip leaves by dipping them in a well-stirred mixture of a tablespoonful of Paris green to a bucket of water, or sprinkling the side next the ground after first moistening, with a mixture of one part of Paris green to twenty of flour, and

placing them at distances of from fifteen to twenty feet throughout the field to be protected. Two applications of this character, at intervals of three or four days, particularly in cloudy weather, were usually successful in ridding the field of the pest.

Other remedial and preventive measures deserving mention are: application of coal oil; paper frames from six to eight inches square; tin bands, ten inches long by two wide, lapped at the ends in a ring; paper wraps around the stalks at setting; and trapping in holes, for the protection of young cabbage and tomato plants; as, also, thick planting and subsequent thinning, and starvation through the removal of all green food, for more general protection. Notice of these several methods may be found in a paper entitled "Cut-Worms," read by me before the New York State Agricultural Society, at its annual meeting, in January of the present year.

Tobacco Worms.

Representation has been made to me that serious and increasing losses are being sustained in portions of Massachusetts, from tobacco worms, accompanied with the request for means of prevention. I am not told what the worm is of which the complaint is made.

If it be the insect that is commonly known as the "tobacco worm," in New York and Connecticut, then it is the larva of a Sphinx moth, bearing the name of *Sphinx quinquemaculata.* The true tobacco worm is the larva of *Sphinx Carolina,* which is so very destructive to tobacco in the Southern States. The two species are very closely allied in appearance and habits, and in Pennsylvania often occur together.

The larva of our five-spotted Sphinx is well-known to all of our tobacco growers. It is a dark-green, smooth caterpillar, with seven oblique greenish-yellow stripes on each side, a long, curved horn upon its terminal end, and, when full grown, is of about the size of the third finger of a man's hand. The moth is a large and handsome insect of a general ash-gray color, its stout body marked with a row of five orange-colored spots on each side. It comes abroad

at twilight for the deposit of its eggs, and so marked is its resemblance to a humming bird in size, rapidity of flight, and its hovering over flowers when taking its food, that the popular name of "humming-bird moths" has been given to that group of the *Sphingidæ* to which it belongs.

The eggs of the moth are deposited upon the tobacco plants during the months of June and July. The caterpillars feed upon the leaves of the plants in late July, August and September, even up to the time of securing the crop. In an instance related to me, in a curing-barn, near Albany, N. Y., shortly after the hanging up of the plants for curing, the floor beneath was found "nearly covered" with the caterpillars of *S. quinquemaculata*. As illustrating the abundance in which they at times occur, it may be mentioned that a market-gardener collected from one acre and a quarter of tomato plants, — a favorite food-plant of the species, — four bushels of the caterpillars, in one day. (*Report of the Entomological Society of Ontario for 1880, page 27.*)

The only sure remedy for the attack of this insect is that which is known among tobacco growers as "worming." The plants must be searched for the worms two or three times a week, or as often as is found necessary, and the worms destroyed. The mornings and evenings and cloudy days are the most favorable for finding them.

Poisoning the moths to prevent the laying of the eggs is also resorted to. A gentleman gives this as his method: "In every tenth hill, on the outside of my field, I sow the seed of Jamestown-weed (*Datura stramonium*), instead of setting tobacco plants. As the Daturas grow up I pull out all but two to each hill, and when these are in bloom I go around every evening, and, after destroying all but two flowers, pour into these a few drops of common fly poison, mixed with sweetened water and whiskey. The moths sip the poison and die from it, and I find them scattered over the farm for the space of several hundred yards." Another writer gives these directions for the poisoning: "Provide a weak solution of cobalt and a little honey, place it in a bottle having a small quill through the cork, and late each evening go around the jimson weeds and put a few drops

of the mixture into the blossoms. The poisoning must be done every day through the fly season, care being taken each evening to pull off the blossoms that were poisoned the day before, as, if left on, they seem to destroy the plants."

So far to the northward as Massachusetts, the Jamestown-weed might not flower in season for the early coming of the moths, unless the seed should be put in as early as possible.

Knowing the attractiveness of the petunia for our Sphinx moths, I would suggest that benefit might be derived from placing a large bed of these flowers in the neighborhood of tobacco fields, and employing children to catch with insect nets the moths that are attracted to the flowers at twilight, and killing those that bear the five orange-colored spots upon the sides of their abdomen. A pair of them and of the several other species of Sphinges that would at the same time be captured, might be preserved and placed in frames with which to ornament their homes, and to serve, perchance, as the commencement of a general collection of insects, and of the fascinating study of entomology.

If the information asked of me be not of these tobacco worms, but of another kind, that attack the roots at their setting, then the injury, without much doubt, is chargeable upon the ubiquitous cut-worm which we have been considering. Fortunately we have two ways — both pronounced excellent — of dealing with him, in order to prevent his immoderate use of tobacco.

The first is, dipping the young plants, before setting out, in a solution of white hellebore in water — one-fourth of a pound in ten quarts of water. A writer from West Meriden reports, that on the 22d of June he set three thousand plants, and on the following morning he took from one row of a hundred and eighty plants two hundred and fourteen cut-worms. On the same day, in the same field, he set twelve plants dipped in the hellebore solution, which remained untouched, while the rows on either side were more than half destroyed. On June 24th he set *over two thousand plants treated in the same manner, of which he subsequently found but one plant eaten, and that but slightly.* He believed the hellebore to be a specific for the tobacco cut-worm.

The second is poisoning with Paris green in the following

manner: Four acres of tobacco plants were badly cut down, with sometimes as many as a half-dozen of the worms attacking a single plant. The owner went to a wood, toward evening, and collected several kinds of leaves, which he laid in rows between the plants. The worms appeared to prefer the leaves of the chestnut for eating. The following day a large basketful of the chestnut leaves was gathered. These were dipped into a mixture of two gallons of water and two tablespoonfuls of Paris green and a leaf put on each hill in the field, with a piece of ground or a stone to hold it in place. The next morning, upon examination, "the worms lay under the leaves like a hill of potatoes; they had eaten little holes through the leaves, and some were dead and others dying." The tobacco was then reset and no further trouble experienced from the cut-worms.

The Apple-Maggot.

An insect which has come under notice during the last twenty years as exceedingly destructive in many localities in the New England States to early apples, even surpassing the common apple-worm of *Carpocapsa pomonella*, is the *Trypeta pomonella* (Walsh), known commonly as the "apple-maggot."

While the apple-worm, with which we have been so long familiar as the cause of the annoying and injurious worm-holes in our fruit, is the offspring of a small but beautifully marked moth, the apple-maggot, as its name imports, is the earlier stage of a fly.

The Fly. — The perfect insect resembles in form the common house-fly, but it is of a smaller size, being only about one-fifth of an inch in expanse. Its wings are white and glossy, and are marked in a pretty pattern with four blackish crossbands, the first of which is near the base, and the other three are connected upon the front margin of the wing and diverge behind. They are thought to represent somewhat the letters I F, with the I placed next the base and its lower end uniting with the lower end of the F. The abdomen has its first four segments broadly banded with white.

Life-History. — The parent fly, during the latter part of July or early in August, deposits a number of its eggs upon or near the calyx end of the apple, selecting often for its purpose fruit that has already been burrowed by the apple-worm. Upon hatching from the eggs the young larvæ enter the apple and commence to feed upon its pulp, not penetrating to the core, as does the apple-worm. Here they produce, at first, little irregularly rounded and discolored excavations of about the size of peas. These, when the larvæ are numerous, run together until the whole interior becomes a mere pulpy mass of disorganized material, or is entirely honeycombed with burrows in the more solid fruit. Meantime the apple is entirely fair upon its exterior and gives no evidence of the destructive work being carried on within. Sometimes as many as a dozen larvæ are working together. Their operations are seldom noticed until in September. When they become full grown, in the autumn, they escape from the fruit through small, round holes that they cut in the peel, and enter the ground for pupation. In this condition they remain during the winter and do not emerge as flies until the following July.

From some recent observations it would appear that the larvæ sometimes are slower in reaching their maturity, and have been found feeding within the fruit so late as in the month of January.

The Larva. — The larva in its greatest length measures about one-fifth of an inch, is without feet, and of a white or (as sometimes) of a yellowish or greenish color. The front third of its body tapers toward the minute, pointed head, which is armed beneath with its mouth-parts, consisting of two slender, blunt, coal-black hooks. The remainder of the body is cylindrical, with its terminal end obliquely cut off, and bearing upon its slope four pairs of tubercles, of which one pair is longer than the other.

From this description the larva should admit of easy recognition whenever its operations are suspected in apples. The absence of feet and its pointed head will serve to distinguish it from the apple-worm.

Distribution. — The fly is a native species, — one of the few of our insect pests which has not been introduced from

Europe. It was first described by Mr. B. D. Walsh in 1867, from examples taken in Illinois, where it was discovered feeding upon thorn and crab apples, prior to any knowledge of its attack upon cultivated fruit. This new habit was first developed in, and was for some time confined to, the Eastern States and New York, but within the last year apples in different localities in Michigan have been attacked by it and entirely ruined.

The most frequent notices of it have been received from Vermont. In New Hampshire it has also become broadly distributed and ruined entire orchards. In Massachusetts it is quite destructive. Mr. L. L. Whitman has informed me that in his orchard at North Ashburnham he had hundreds of bushels of the finest fruit rendered worthless by it in 1883. Mr. Avery P. Slade of Somerset reports it the present year as honeycombing his apples. Several years ago its operations were observed in Connecticut, and it has been discussed in the late meetings of the State Board of Agriculture. From Brunswick, Maine, it is reported by Mr. T. S. McLellan as having made its appearance in his orchard in 1880, and infesting all his sweet apples and most of his tart ones, such as the Haley, Hurlbut, Primate, Porter, etc. He had also heard of it from the northern part of Somerset County (*27th Ann. Rep. Maine Board of Agriculture for 1883*, p. 345). Mr. Robert H. Gardiner, President of the Maine State Pomological Society, states that the maggot was very destructive in 1883 to his Tolman Sweet, Red Astrachan and Mother apples, but did not trouble other varieties (*Ib.*, p. 332).

In the State of New York it has proved a great pest at North Hempstead, Long Island, and in several of the Hudson River counties, and has also occurred in Delaware, Albany, Schenectady, Oneida and Chemung counties, and is doubtless to be found in many other portions of the State. As yet we have no knowledge of its extension into New Jersey, Pennsylvania, the Southern or the extreme Western States.

It appears, thus far, to be a local insect, and the fact that it is so should be an incentive for the use of every known means for the prevention of its distribution, that it may not

become as generally distributed as is the apple-worm of the codling moth.

Preference for Early Apples. — The insect in its past history, especially in its earlier history, has shown a marked preference for summer and autumn apples — always making its most vigorous attack upon sweet and mellow subacid early fruit. Yet it is known to have infested Spitzenbergs, in Brandon, Vt., and Baldwins and other varieties of winter apples, in Wallingford, Conn.

Remedial Measures. — This preference of the insect for certain varieties might be employed as a means for its destruction, by grafting the trees of an infested orchard to the varieties less liable to be infested, or, so far as known, entirely free from attack, and at the same time leaving two or three trees of its favorite fruit to serve as lures for concentrating the attack — the fruit of which should be gathered at the proper time and be destroyed with all of the contained larvæ.

If it shall be found that any considerable proportion of the fruit containing the maggot falls to the ground as a consequence of the attack, then, of course, much benefit will be derived from gathering the fruit as fast as it falls and destroying it, or to give sheep the range of the orchard for feeding upon it. But as I have examined fruit offered for sale in the Albany market, presenting so fair and perfect an appearance as to prove beyond a doubt that it had been picked by hand from the tree, and yet teeming interiorly with nearly mature larvæ, it is highly probable that their presence does not cause the falling of the fruit.

Our study of this comparatively new insect depredator has hardly commenced. Careful observations are needed upon the time and manner of the larvæ leaving the fruit, and, in the earlier varieties of apples, when they enter the ground. In the later and stored varieties, it is important to know where they betake themselves for their pupation during the winter. Until these facts are definitely ascertained, together with others that are necessary to the completion of its life-history, we shall not be able to accomplish much toward mitigating the evil. We can prevent the attack of the apple-worm by showering the trees, soon after the set-

ting of the fruit, with Paris green or London purple in water, without the least possible chance of injuring the fruit through the poisonous application. But the month of July — when the Trypeta deposits the eggs that produce the apple-maggot — would be too late to apply such substances to the fruit with safety, already nearly full grown and soon to be eaten.

Perhaps, for the present, the best results may attend our efforts to destroy the insect in its pupal stage. If examination should show us that the pupation ordinarily takes place in the orchard, beneath the infested trees, then we may reach it there. But if the pupation follows the gathering and storing of the fruit, — as seems more probable, — then the discovery of the retreat of the larvæ should give us the means for destroying them.

Desiderata in its Life-History. — In my forthcoming report I have indicated several points upon which knowledge is needed toward the completion of the life-history of this insect. I will introduce them here, accompanying them with the earnest request that you will each, as opportunity may offer, make contribution, to your ability, toward the desired knowledge of this already great pest of our orchards, and which gives every promise of soon becoming still more pernicious. It is manifesting a tendency to widespread distribution, and an unusual adaptability to different varieties of fruit. It would not be surprising if it soon attacked our pears.

Are the eggs of the fly distributed over the apple or placed only near the calyx end?

Do the larvæ occur in apples which have not been perforated by the apple-worm of the codling moth or by some other insect?

How long a time is required for the larvæ to attain their growth?

How do the larvæ leave the fruit, — by several holes through the skin, through a single hole, or only when the apple has become broken down from decay?

When entering the ground for pupation, to what depth do they bury? This could be ascertained by providing them with a box containing a few inches of earth for burial.

Are both the early and late fruits similarly attacked by this insect? It is possible that the larvæ reported in winter apples may be of a different species.

During what months and portions of months are the larvæ to be found in the apples?

Are the puparia to be found at the bottom of apple barrels, or bins in cellars, or between the staves or boards? Should any doubt exist of the identity of the puparia found under such conditions, the fly should be reared from it to determine the point.

The Asparagus Beetle.

Information upon this insect is desired, and may very properly be given at the present time, as it has but recently extended its depredations into Massachusetts. It is a much easier task to arrest the spread of a new insect pest, than to control its ravages after it has taken full possession of its new territory and perfectly adapted itself to its new conditions. It is therefore important that the insect should be known, so that it may at once be recognized, and prompt measures resorted to, in order to check its increase.

Description. — In general shape and size it resembles the well-known cucumber-beetle, *Diabrotica vittata*, but it is somewhat longer, being about a quarter of an inch long, and its body is more elongated from its parallel sides. It has a black head, and a finely punctured tawny-red thorax, marked with two black spots upon its crown. The lemon-colored punctured wing-covers are usually broken into three spots each, by a black stripe along their junction, a black transverse band a little beyond their middle, and an interrupted one near their tips; outwardly they are bordered with orange. The body beneath and the legs are shining black. The elytral markings, as above given, suggest to some the representation of a black cross, for which reason it is sometimes known, in England, as the "cross-bearer." Other examples of the beetle, not unfrequently met with, may be described as having their wing-covers blue-black, margined and tipped with orange, and with three small yellow spots in a line down the middle of each cover.

Its Associates. — The scientific name of the beetle is *Crioceris asparagi.* It was first described by Linnæus, nearly a century ago. It belongs to the same destructive family of the *Chrysomelidæ* with the striped cucumber-beetle, the cucumber flea-beetle, the grapevine flea-beetle, the Colorado potato-beetle, etc. For a long time it was the only representative of its genus in this country, but another species has recently been introduced from Europe, — *Crioceris 12-punctata,* — which was first observed in the vicinity of Baltimore in 1881, and already gives promise of becoming quite destructive to asparagus.

Its Introduction. — *Crioceris asparagi* is an European species, which our commercial and other relations with the old world have brought to our shores, in common with a large number of our most destructive insect pests. It was first noticed upon the eastern end of Long Island, at Astoria, in the year 1859, and it is worthy of note that, in the same year, the first specimen of another very injurious insect, also introduced from Europe, — the cabbage-butterfly, *Pieris rapæ,* was taken, in the city of Quebec. As early as 1862 the beetle had spread over all the asparagus plantations of Long Island. The following year it was attacked by a parasite which destroyed its eggs, and doubtless aided much in arresting its increase. The parasite was not described. It probably disappeared before it could receive scientific attention, for nothing seems to be known of it at the present.

Its Distribution. — In 1868 the beetle had extended its range into New Jersey, where, in the third year of its observation, entire beds were ruined by it. Its rate of distribution, in its earlier years, appears to have been about twenty miles a year, but fortunately this has not been sustained. During the twenty-five years that have elapsed since its introduction, it has not shown a disposition to extend far from the sea-coast, nor to a great distance from New York City, as its course of operations. Serious injuries from it have only been reported from Long Island, the vicinity of New York City, Southern Connecticut, New Jersey and Eastern Pennsylvania. It has not been seen at Albany, although during the last year I have received examples of it collected at the New York State Agricultural Experiment Station, at

Geneva, a locality that lies to the westward of the central portion of the State. An equal extension from New York could carry it into any portion of Massachusetts. It is a matter of surprise to me that it has not made, long ere this, formidable demonstration in the eastern — particularly the seaboard — portion of your State.

Its Natural History. — The history of *C. asparagi* is, in brief, as follows: The beetles destined to continue the species survive the winter in dry, sheltered places, as beneath bark, in crevices of wood, and under the clapboards of buildings. Simultaneously with the appearance of the asparagus shoots in early spring, they emerge from their winter quarters, and commence to feed upon the tips of the plants. The sexes pair, and the female deposits her eggs upon any portion of the exposed shoots. The eggs hatch in an average period of eight days. The larvæ eat voraciously and grow rapidly, so that they complete their growth in about twelve days. They then leave the plants and enter the earth for a short distance, or merely conceal themselves beneath dead leaves or other material on the surface. Constructing a slight cocoon, they undergo their transformation, and remain in their pupal state for about ten days. Thirty days complete the cycle from the egg to the perfect insect. Almost as soon as the beetles emerge they pair, as the sexual instinct is strongly developed in them, as is shown in the frequency in which they come under our observation mated. The eggs are then deposited, and the beetles continue to feed upon the plants, eating holes into the bark of the more tender branches for several days: one was found by Dr. Fitch to feed for a fortnight in confinement. A second brood results from these, appearing about the first of July, followed by a third, probably in August. Hence we have the larvæ and the beetles with us, in their successive broods, through the spring and summer, into September.

Remedies. — Among the remedies proposed and employed against this insect are the following: Hand-picking, when not too abundant, and beating them from the plants into a broad pan of water and kerosene.

Employing fowls to hunt them, which are very eager in

catching and eating the beetle, and are not injurious to the plants.

Cutting away all the young seedlings in the spring, at the time when the beetle is about to deposit its eggs, thus forcing them to lay their eggs upon the new shoots, which are cut and sent to market before the hatching would occur.

Benefit has been derived from cutting down the seed-stems at the close of the season, as also once or twice during the season, leaving the beds bare and smooth.

But undoubtedly the best method with which to meet this insect is by the lime application proposed by Mr. A. S. Fuller, of Ridgewood, N. J., as the result of his personal and successful experience. The freshly-slacked lime, he states, may be conveniently scattered over the plants by using an old broom for a duster, or a Paris-green sifter. With a pail full of the lime, a man could in a short time dust an acre of asparagus. It could best be applied in the morning while the dew is on, for then a portion will adhere to the plants as well as to the grubs, and during the day or days following it will be constantly dropping down or blowing about among the leaves and branches, thereby making the escape of any of the larvæ all the more uncertain.

For the past sixteen years, Mr. Fuller had, according to his statement, used lime as described, upon his asparagus beds, to keep the insect in question in check, and it has done it so effectually that about one application every alternate season was sufficient. Not only is lime cheap and readily procurable everywhere, but it is of benefit to the asparagus roots. It has also the additional merit as an insecticide, that it can be used upon the young plants while they are being cut for market, for the destruction of the first brood of larvæ, while Paris green or London purple may not safely be employed.

The Grapevine "Thrips."

Frequent complaints are made of the damage done to grapevines, from an attack upon their leaves by the "Thrips." This is a popular name — but an incorrect one, as will be shown hereafter — which has obtained widespread currency among vine growers for some small (about an

eighth of an inch long), slender, spindle-shaped, parti-colored leaf-hoppers, which are very destructive to the foliage of grapevines. They abound upon the leaves in their three stages of larva, pupa, and perfect insect, in each of which they are injurious. Their injury to the leaves is caused by puncturing them with their beak or proboscis and feeding upon the sap. They are usually to be found upon the under surface of the leaves. The punctures first produce small discolored spots, which are multiplied over the surface, and rapidly increase in size by their running together and by the greater suctorial power of the growing insect. Later they become large brown blotches, which, if the insects are numerous, extend over and embrace the entire leaf, causing it to dry, — appearing as if scorched by fire, — to die, and fall from the vine. As a consequence of this partial defoliation, the fruit is dwarfed and its ripening interfered with, and the death of the vine may follow if the insects have been very numerous. These little creatures belong to the order of HEMIPTERA, which embraces a large number of our destructive pests, as the plant-lice (*Aphididæ*), the scale-insects and the mealy-bugs (*Coccidæ*), the grape Phylloxera, etc., — all of which subsist only upon liquid food, but fully equal in destructiveness those provided with formidable biting jaws.

Several species of these little leaf-hoppers are frequently associated upon the grape leaves. They belong to the genus known as *Erythroneura*, and the more common one is that described by Dr. Harris in 1831, as *Tettigonia vitis*. It is about one-tenth of an inch long, of a pale yellow or straw color, with two narrow red lines on its head, and scarlet bands upon its thorax and wing-covers. It appears in June, in its larval stage, when it may be found quietly resting upon the leaves, with its beak thrust therein, unless it be disturbed, when it hops briskly to another leaf. They cast their skins from time to time, as they increase in size, and numbers of these white, empty cases may be found fastened to the under surface of the foliage or scattered on the ground beneath. In July they assume their pupal form. In August they mature and acquire wings; when, if the vines are shaken, they may be driven up in swarms, but

only to return and resume their destructive work. The winged insect survives the winter, hibernating among the dead leaves or in other sequestered places. The following spring, in the month of May, it comes forth from its retreat, and deposits its eggs upon the leaves of the vines for another brood.

The *Thrips* proper is an entirely different insect. It is a smaller insect than the grapevine leaf-hopper, with long and narrow wings, without veins, and bordered with long fringes —the two pairs of about equal size. There are a number of species united in the family of *Thripidæ*, the location of which, in our classification, has been the occasion of much discussion and is still in doubt. By Halliday it was set apart in a distinct order, under the name of THYSANOPTERA, and this arrangement has been accepted by many entomologists. Dr. Packard and others regard it as properly placed among the HEMIPTERA, to some of the families of which it seems to have a close affinity. Their habits vary greatly; for while many of the species are unquestionably vegetable feeders, and injurious in their operations, others, from their carnivorous propensities, are serviceable in their destruction of gall-insects, the eggs of the curculio, the red spider (*Tetranychus telarius*), the clover-seed midge (*Cecidomyia leguminicola*), the wheat midge (*Diplosis tritici*), and other insect pests.

The method commonly resorted to for the prevention of the ravages of the so-called "Thrips" in graperies, has been fumigation with burned tobacco. This has proved to be partially successful. A still better method has been for some time employed in France, but not to my knowledge to any extent in this country. It is the vaporization of a strong extract of tobacco. One who has thoroughly tested it bears this testimony to its efficacy: "Ever since I adopted it, it has been absolutely impossible to find a 'thrips' in my houses, and other insects have likewise disappeared." The following method of use is given:—

Every week, whether there are insects or not, I have a number of braziers containing burning charcoal distributed through my houses. On each brazier is placed an old saucepan containing about a pint of tobacco juice of the strength of 14°. This is quickly vaporized, and the atmosphere of the house is saturated

with the nicotine-laden vapor, which becomes condensed on everything with which it comes in contact When the contents of the saucepan are reduced to the consistency of thick sirup, about a pint of water is added to each, and the vaporization goes on as before. I consider a pint of tobacco juice sufficient for a house of about 2,000 cubic feet. The smell is not so unpleasant as that from fumigation, and tobacco juice can be used more conveniently than the leaves.

When the operation is completed, if the tongue is applied to a leaf one can easily understand what has taken place, from the very perceptible taste of tobacco.

The process requires to be repeated in proportion to the extent to which a house is infested. Such troublesome guests are not to be quite exterminated by a single operation. A new brood may be hatched on the following day, or some may not have been reached on the first day, so that the vaporization should be frequently carried on, until the insects have entirely disappeared, and after that it should be repeated every week in order to prevent a fresh invasion.

The tobacco juice of the proper strength is purchasable at the tobacco factories in France for about fifteen cents (of our money) a quart. Its expense, at this rate, would be but about twenty-five cents a week for a grapery of about fifty feet by sixteen and ten.

A strong infusion of tobacco leaves, made by boiling, would be a substitute for the above. It might be prepared in quantity and evaporated to the proper degree, for convenience of keeping and for ready use.

Although the so-called thrips — it might properly be designated the "grapevine leaf-hopper" — is more abundant within the shelter of graperies than elsewhere, still, in favorable seasons and in certain localities, it is a great pest in vineyards, where it is less amenable to remedial measures. Early in the season, while yet in its larval stage, benefit has been derived from showering the lower surface of the leaves with an infusion of tobacco or of soapsuds, or of both combined. A still more effectual application should be spraying with an emulsion of kerosene oil and common soap, made after the formulas given for its preparation.

Another method has been used for destroying this insect, with good results, it is stated. A long strip of building-

paper is smeared with coal-tar on one side, and stretched between the rows, when, with a brush, the insects are driven up from the vines against the sticky surface, to which they adhere. Two men and a boy can go over a vineyard in this manner in a short time, and a few repetitions will nearly exterminate them.

The Rose-leaf "Thrips."

This little pest, which is almost always present with us during the summer months, to mar, if it does not destroy, the leafage of our rose-bushes, is a near relative of the insect which we have been discussing. It is the *Tettigonia rosæ* of the Harris reports, — a small, yellow-bodied leaf-hopper, with white and transparent wing-covers and wings, and brown eyes and feet. Its life-history closely resembles that of *Erythroneura vitis*, of the grape.

Perhaps the best preventive of injury by this insect is an infusion of tobacco, prepared in the following manner: Where the tobacco stems can be procured, place some of them in a vessel of the capacity of a common pail and pour boiling water upon them until they are covered. Allow it to stand over night, and when used dilute it with five times the quantity of water and apply it to the under side of the leaves with a garden syringe, or force pump with a rose nozzle. The application should be made in the evening, or early in the morning, and, particularly, early in the season, before the injuries become noticeable except from close examination, and as soon as the young larvæ, looking like little white specks, are discoverable on the under side of the leaves. The showering should be repeated from time to time so long as the insects remain or the effects of their presence are noticeable.

I had intended asking your attention to a few other insect pests which are annually demanding heavy tribute from you, and which you are voluntarily paying — not necessarily, for recent discoveries in economic entomology have given means which only need to be properly used in order that the burden of insect injuries shall be materially lightened; but I have already exceeded the time allotted for my paper.

May I hope that the details presented — some of which I fear may have been found dry — may not have greatly wearied you.

The CHAIRMAN. Now, gentlemen, we will take up the discussion of the corn crop, which we left unfinished this forenoon. Mr. Cushman rose just as the meeting adjourned, and if he desires the floor now we shall be happy to hear from him.

Mr. CUSHMAN of Lakeville. Quite a number of years ago I was a member of a Farmers' Club, and I believe I was one of the first in that vicinity to announce that I could make a cow give as much milk on a half-ration of corn stover and English hay and a ration of grain, as I could with clear English hay and the same ration of grain. I extended my experiment with corn stover over a fortnight, and then alternated with a fortnight of English hay. I have no scales in my barn, so I cannot keep an accurate account of the weight of the animal. That should come in as a factor in our experiments. Our Boston cans are very convenient in keeping an account of the quantity of milk, but it was not so convenient to keep an account of the weight of the animal, so as to determine whether, when she was giving her milk from corn stover, she maintained her weight. But on further experiment I found that, to keep up the flow of milk, it took from twenty-five to thirty-three per cent. more in weight of corn stover than it did of English hay; and I think that we sometimes are led into a mistake in our estimate of the value of corn stover, for I think it takes about three pounds of corn stover to satisfy the animal craving, whereas it would take about two pounds of good English hay. That is merely the result of my own private experiments, on a limited scale, and I do not pretend that they are conclusive. I know that isolated experiments are of but little value. I merely give that as the result of one trial.

Then, in regard to the application of half a ton of commercial fertilizer every year to an acre, to get a certain amount of crop. Gentlemen, it seems to me, that it is about time for us to exercise the same intelligence in the feeding of crops that we do in feeding animals. You would not employ

a foreman who would go through a herd of cattle such as we saw this morning in the stables of our friend Mr. Bowditch, — cows, oxen and young cattle, — and indiscriminately throw over four quarts of grain to each animal and the same quantity of hay to each. You would say that the man should know something of the wants of each individual animal, in order to feed intelligently and profitably. Now, it is just as important for us to know, not only the wants of the crop to be grown, and the elements that enter into its composition, but we want to know the condition of the soil to which the application is to be made. For instance: I have grown corn this year with half a ton of fertilizer on an acre, which, next year, with an ordinary season, will ensure me 75 bushels of shelled corn, I have no doubt; another acre, with the same application, would ensure me but 25 bushels. It is hardly good husbandry for me to go on and make the same application to all the acres of my farm. It is a very difficult matter indeed for us to tell how much of any kind of fertilizer to apply, to ensure us a given crop; and it seems to me that we are commencing at the wrong end of the string, in making up our estimates of the cost of a crop, as I remarked here yesterday afternoon, in charging any amount of fertilizer to the crop, when we do not know anything about the amount taken out of the soil to produce the crop. It seems to be blind reasoning. But the chemist comes to our aid and tells us something about what we have taken out of the soil. The gentleman upon the platform yesterday afternoon told us that a bushel of shelled corn cost about 19 cents, or had that amount of plant food in it; and he told us that if an animal consumed two bushels of shelled corn, she had consumed 38 cents worth of plant food. Now, I have merely to remark, that it seems to me that the plant food in a bushel of shelled corn and its stover cannot, at the present prices of chemicals (and those are our guides), be produced in the market for less than 25 cents; and it does seem strange to me, — it is one of the many inscrutable things in agriculture, — that a bushel of corn, with its stover, can be grown for less than the worth of the plant food that enters into its composition, any more than a pair of boots can be manufactured for a little less than the leather is worth of which they are

made, or a box be made for less than the boards are worth in the rough state. I think, gentlemen, it is the easiest thing in the world for us to be misled. I believe the story is good enough, that can be told of the cultivation of corn, if we stick close to the plain facts, and allow the full value of all the plant food, and add the cost of cultivation and all the other items that enter into the cost of the corn crop.

Mr. HASTINGS of Framingham. Mr. Ware, in speaking of harvesting corn, said that the best way was to cut it up as soon as the ears were glazed over and stack it in the field, if I understood him right, and he stated that the stover was worth $15 a ton. Now, I have yet to learn that any one can cut up corn in that way, stack it in the field, and let it get sufficiently dry to harvest that corn and put it into a bin, and then have that stover worth two dollars a ton; for every one knows that that stover will get almost rotted. If we have the usual rains, it gets wet, mouldy, and nearly worthless. If I take stalks that have been cut at the proper time, let the ears and lower part stand, and cure them a day or two and put them into the barn in a proper way, and then, when the corn is harvested, husk the corn, that stover, with the stalks already secured, I think, is worth as much as English hay, pound for pound.

Mr. WARE. I am very glad to see that our friend Hastings agrees with me so fully in my position, that corn stover, well cured, is worth, ton for ton, as much as English hay. I do not advocate the advantages or the value of rotten stover. Mind you, I said *stover well cured*, and he agrees with me entirely. It does require considerable courage in any one, especially a farmer, to take a position contrary to the generally received ideas of farmers in their past methods of cultivation, and I feel that taking the position that I did this forenoon required a good deal of courage; but I have been subjected to hard knocks on the farm all my life and in later years on the rostrum. I am not very thin-skinned, and I can bear them for the sake of the good of the cause that I have near at heart. There are gentlemen here present who could confirm what I have said if they would. I do not know whether they will dare to come forward and state the truth as it is in them or not, because it

takes courage to do it. I have been subjected to jeers during the intermission, but I took them all in good part, and rather enjoyed them. Farmers have come to me and said, "Mr. Ware, you have put the cost of labor too high, and the cost of some other items too high." Well, I told you this forenoon I intended to be liberal, so as to make a fair allowance for any circumstances that might not always appear; I intended to place the cost high. Another one says to me, "I don't agree with you; you put the corn stover too high;" and immediately he says, "Last year I bought four tons of corn stover for eight dollars a ton and hauled it home to my barn. That corn stover did me as much good as what hay I could have bought for a hundred dollars." (Laughter.) There he makes his corn stover worth $25 a ton, according to his own statement, and yet he was not quite willing to agree with me because I put the value of corn stover so high! My valuation was $15 a ton; and there are others here who, if they will state their experience in feeding corn stover, will corroborate my statement. It was said here this forenoon that cattle did not eat more than half of it, but that the half they did eat was as good as English hay, and, therefore, the speaker estimated the value of the whole at one-half that of English hay. If he does not make his cows eat more than half, he does not feed them judiciously. There are men who feed their cows corn stover and make them eat it all up, and they thrive. You and I have seen, to-day, corn stover put before cattle, not more than half prepared, as I should consider; taken in from the frozen fields, and fed out in that condition; but still the cattle ate it and looked pretty well.

QUESTION. You use the term "well-prepared corn fodder." How would you prepare it?

Mr. WARE. I say that corn stover, well cured, is in a fit condition to put into the barn, where it will not heat. If it does mould a little when packed away in the mow, it does not injure it at all, and cows and other cattle love it better than if it is not mouldy. I suppose it adds a little zest to it, as a little mould does to old cheese.

Mr. DAMON of Plymouth. That is my experience. I have heard it said to-day that corn fodder gotten in this week

would be better than that gathered in the condition that you describe. I have never had any experience in leaving it out until winter.

Mr. Ware. I do not think that cows like it thoroughly dried, as well as they do if it is not allowed to get so dry but that it will mould a little. There is another gentleman here present who said to me, "Mr. Ware, don't yield one iota of the position you have taken; you have told the truth." I think I have; but I confess that while what I said was the truth, I did not tell the whole truth, because I did not think this audience was in a condition to bear the whole truth at this time, so I put it light. (Laughter and applause.)

I do not want to occupy the time, because there are other gentlemen here whose experiences, if they will give them, will confirm my position and more too. I will yield the floor, and I want some of them to come to the front. I will take the brunt of all the jeers, the fun and the jokes.

Mr. Damon. The gentleman has not quite answered my question in regard to the worth of corn stover, cut up and stacked as he spoke of, as compared with what it is worth when the stalks are cut, cured a day or two in the field, and then the husks packed away with them.

Mr. Ware. You mean, the top of the stalks cut off first?

Mr. Damon. Yes.

Mr. Ware. My opinion is that the method I have suggested saves a great amount of labor; and all my statements have been made, as you will observe, with a view to the saving of labor. It will not only save a vast amount of labor, but if the corn is stowed properly, it will be in good condition, and do as much good to the cows as if put in as you suggest. That is my opinion. I do not expect to have it rotten, though, as you say.

Mr. Edson. The gentleman wishes to know how to cure corn fodder properly. My plan is to stack it in the field, after the corn is glazed over, and when it gets dry enough to husk, we husk it in the field, put two stacks into one, bind them up, and let them stand until we want to use them. They will keep perfectly in that way and not mould. If the gentleman will try that plan with his corn fodder I think he will succeed. That is the custom in Pennsylvania.

They put their corn in shocks and do not husk it until they want to take the stover from the field; then they husk the corn and take the stover out. If you undertake to husk it and put the stover into the barn, in the condition the gentleman speaks of, the cattle will not eat it; but if you stack the stover in the field, and leave it there until you want to use it, it will keep perfectly.

Mr. CHAMBERLAIN. I shall make no statement that my own personal experience has not fully confirmed. I fully agree with the essayist of the morning in relation to the necessity of corn fodder as part of a ration for our stock. I think there is a unanimity of opinion on this subject that is seldom seen in a meeting of this kind. There is also a good degree of unanimity in relation to the production of corn and the method of caring for it. It does not seem to be necessary to say a word about that. The salient point of the essayist this morning, and the one upon which he insists this afternoon, is in relation to stover, — its value, and the best method of feeding it. That is an important question. If it is not worth anything, then the cost of the seed is going to be too much for the profitable feeding of our cattle; if it is worth as much as English hay, then the stover covers the cost of the whole crop, and you have got your corn for less than 25 cents a bushel, and your cattle have it for less than nothing. Now, is that a fact? If the gentlemen here believe that to be a fact, then there is nothing more to be said. We are certainly doing blind work if we feed hay at $25 a ton, when there is plenty of good corn ground all about us, lying comparatively idle. It appears to me that some of us, who have been feeding fifty years, more or less, ought to know the cost of a given ration for our cattle; but I submit that we have been guessing. I venture to say that there are not ten farmers — I do not know but I should be within bounds if I said five farmers — in this audience who have ever weighed a stack of corn, or a day's rations for their stock. They simply guess at it. What should you say of a cotton manufacturer, if he should tell you that he *guesses* it takes so many ounces of cotton to make a yard of cloth, and he *guesses* each yard of cloth costs so many mills? I guess you would say he would not be able to compete

with his neighbors unless he had a heavy purse, and if he had, it would grow light very rapidly.

For the last three years, I have been trying to be careful upon these matters. When the ensilage enthusiasm began, I said to myself: "If ensilage is so valuable, I must have ensilage, but I want to compare it with what I have heretofore got with corn." I commenced my investigations, and I have carried them on with just as much care as I have been able to exercise. I have found out that it is necessary to give my cows about one-half of their ration, in pounds, of stover, with the same quantity of corn, in order to have them do well. I have found that corn will yield in about that proportion, — one pound of ears to one pound of stover. So far, I have got a perfect ration; I have found, also, that ten pounds of corn meal and ten pounds of stover make an average day's ration for my milch cows, — twenty pounds in all. That I have proved by the last three years' experience. That has been the result with me. I do not say that you could do the same thing, or that the result would be the same. I mean to say just what Mr. W. W. Rawson said in our Farmers' Club last winter: "I have given you the details; now, I am not afraid of your doing me any injury, because there is not one in ten of you who can go home and do what I have been doing." So I say to you, that your conditions may be so varied that you will not reach the same result; but I believe you will come to the same conclusion that I have, that it takes ten pounds of grain, — it does not make much difference what grain it is, if it is ten pounds of good sweet grain, — and ten pounds of good dry stover, to make a day's ration for a cow. The ration that I have given in relation to corn is a full, complete ration; it is all that a cow will take. It is not only enough, but it is all that your cows will consume.

Now, give them the same ration of hay in place of the stover, with the same quantity of grain, and what is the result? In my barn, for the ten or twelve pounds of stover, I have got to feed thirteen or fifteen pounds of hay. In other words, thirteen or fifteen pounds of hay will equal ten or twelve pounds of stover. I have fed English hay, the best I can raise, whether it be clover, herdsgrass, or mixed

grasses. I continued the experiment for five months last year and three months the year before. I commenced the first of October this year with stover, and my cows have not eaten anything else up to the present time. And these experiments were continued alternately from two to three weeks, so I concluded that I had got down to a right basis. This ration of stover is not only less than the ration of hay, but the milk is increased instead of diminished. My friend Mr. Fairbanks of West Brookfield told me to-day that his cows increase in the flow of milk when he begins to feed stover, and when the stover is gone they begin to decrease.

I wish to say that no stover should be wasted, and I sometimes see enough stover wasted to make the difference between profit and loss on any farm. Now, how are you going to make your cattle eat it? I freely admit that there is a portion of stover that is not palatable, and if your cows are fed as they ought to be they will leave a portion of it. There are various methods of disposing of that portion. I think my friend Mr. Brooks suggests the most practicable way. I give each of my cows five pounds as a ration of stover. They leave a certain portion, more or less. That is taken out of the crib and is cut very fine, and is mixed with the meal that they are going to eat. You see there will be four or five pounds of meal to one or two pounds of stover. Therefore, they must eat it if they eat the meal. If there is any of it left, it may be said there is not much goodness in it. I hold that there is this value to it: The grain is too concentrated for the animal's stomach to be digested in the best possible manner. This cut stover, when mixed with it, lightens and divides it. One benefits the other very essentially, while both are made more palatable and digestible. I wet the stover so that the meal shall stick to it. I think warm water would be better, but there is considerable expense and labor attending that, and I have to economize labor to make ends meet at the close of the year. Mr. Brooks has a small steam engine with which he cuts up his stover, carries it to his silo and fills it, and in that way it is all made palatable. He plucks his ears, throws them on the ground and they cure perfectly, he tells me. I am inclined to think that is a most excellent way. Then it

is so fully matured that it can be put into the silo, and, if properly pressed, it remains sweet, and there is none of the injurious acid which we get from ensilage made from green stover. Southern corn, which is mere ensilage grain in our climate, should never, in my judgment, be planted, because we can do better with our northern corn. When we buy grain, it takes most of the money that we can make to pay for it; but if we raise it, we feel independent.

My experience for the last three years shows this: That we have made ourselves independent. We are not dependent upon transportation or anything else. We have full rations in our barns, and at comparatively small cost.

It is apparent to you all, that the important thing is to weigh carefully what you feed to your stock. I want to urge you this winter not to guess, but to weigh carefully and see what is the result; and depend upon it, in two or three years hence, when we come together, we shall agree on ensilage just as we do in regard to the necessity of the corn crop. Work it up in the way you can best do it in your different circumstances, so that your cows shall relish the whole of it and consume it all. Then you will have a perfect feed, and you can sell your hay or you can work it up at home.

I thought this spring I would know just what my corn cost me. I had a four-and-a-half-acre field that I thought was favorable to try the experiment upon, and I kept an exact account of every day's woık and every dollar spent. The cost per acre of that whole field was $34, including manure, interest on land, and all those items, substantially the same as presented on the platform. Some of the items were a little more, some a little less, but substantially the same. I paid for husking seventy-one bushels of shelled corn from the best acre of that land. I believe the man was honest and gave me seventy-one bushels of shelled corn. The cost on that acre was $34 and some fraction. The stover on the field was worth $60. What is the corn worth? You can figure it up.

QUESTION. Will you tell us what the cost of the fertilizer was, and what you used?

Mr. CHAMBERLAIN. I used ground bone solely. One ton was applied early in April, when the ground was partially

covered with snow, and the other ton was sowed at the time of planting. The ground was in grain the year before. About eighty dollars' worth was applied to the whole lot of four and a half acres. I paid $38 for one ton and $40 for the other. I ploughed the ground immediately before planting.

Mr. WILLIAMS of Shrewsbury. You give ten pounds of cob-corn meal a day to a cow and ten pounds of stover?

Mr. CHAMBERLAIN. Yes, sir.

Mr. WHEELER of Great Barrington. While the experiment of the gentleman to determine the relative value of corn stover and hay seems to be plausible and reasonable, it strikes me that it may, nevertheless, be misleading. As I understand him, he feeds to each of his cows ten pounds of meal and ten pounds of corn stover, or fifteen pounds of hay. It takes more of the hay to satisfy their wants after eating the meal than it does of the stover, and hence he places the nutritive value just in that ratio one with the other, and concludes that the corn stover has more nutritive value than hay, because his cows are satisfied with a less number of pounds of it than of hay. Now, may it not be the fact that they do not absolutely need either of them? — that some neutral substance that has not any nutritive value in it would satisfy them? A cow eating ten pounds of good solid meal will be pretty well satisfied if she can get some straw, or anything that serves the purpose of distending the stomach. I think there is a point that may come in, and I should want some other test of the relative nutritive value of the two foods than the one which has been given by the gentleman, before I should be willing to pay as much for corn stover as I would for good hay.

Mr. JOHNSON of Framingham. We have had the subject of corn discussed in this hall a great many times within the last twenty years. I have stated here, years ago, when it did require courage (it does not require any courage to-day at all), that the stover from an acre of good corn was worth as much as the grass upon any acre that was cut in town, excepting some of Mr. Bowditch's very heavy grass. I say to-day that that is true. I have said publicly that corn fodder would make more milk than English hay. I say so to-day.

Feed the cattle what they want. I am not so thoroughly posted as our friend Mr. Chamberlain. I have never weighed my corn fodder; I have had my hay weighed that my cattle have used. I have also had my corn fodder estimated on the ground, and know how long it kept my cattle. I was obliged one year to buy some kind of feed for my cows, and I bought of a neighbor of mine a bay of corn fodder. He topped his corn. I did not want the tops; I took the bottoms. I paid him thirty dollars for a bay of fodder, and, if I remember right, when we measured it, there was a little over four tons. It was the best lot of corn fodder I ever had in my life. That fodder lasted my cows as long as a hundred dollars' worth of English hay would have lasted. I say this because I was once driven into the necessity of buying hay to carry my cattle over six months, the city of Boston having covered my land with water. Then I found out what hay cost. My cows ate hay beyond measure; they would eat any amount of it. But corn fodder would stand by. If I had bought hay instead of the husks, it would have cost me more than seventy-five dollars to have kept my cows. I knew then, and know now, how long my cows had been feeding on hay; I knew about how much they ate; I knew that the husks carried them along as well and better than my own hay would have done.

The CHAIRMAN. We must pause in the discussion here, in order to afford an opportunity for some questions on the subject of the lecture.

Mr. JOHNSON. I would like to inquire of Prof. Lintner if he can tell us how to kill the maggot in onions.

Prof. LINTNER. The gentleman makes the inquiry about a very difficult insect to control. It is the larva of a small fly, about the size of a common house-fly, and of very much the same general appearance. It deposits its eggs about the root of the onion, and from that a small maggot is hatched, which bores into the onion. The best method is to prevent the deposit of the eggs, if possible. We have several substances that we think answer an admirable purpose towards preventing that attack. A few years ago I advanced the idea that as insects deposit all their eggs through the

sense of smell, if we could apply to growing plants any strong-smelling substance that would overcome the natural odor of the plant, the insect would not be able to recognize the odor of the plant, and would not deposit its eggs upon it. Among the preventives of the onion maggot I know of nothing more effectual than gas tar, which is a strong-smelling substance. It can be very easily applied. I may also mention that another excellent preventive, which has been found very efficient in preventing the attacks of the onion maggot, is a substance which you will all know, when I mention it, is a very odorous one, — the drainage from pigstyes. If by any means that can be preserved and applied to the onion bed, it will be found a very excellent preventive. If it is a violent attack, the onion plant should be at once lifted up and some corrosive substance poured into the hole to destroy the larvæ remaining there; but if it is not a severe attack, then, if some sand be moistened with kerosene, you can just let it run through your hand, and apply this to the onions, and it will usually, if a rain falls soon after, be carried into the soil and destroy the larvæ which are feeding upon the plants. The head of the insect is always thrust into the plant, and you can only reach it through its body.

Mr. Slade. Have you ever noticed a small bug, or strawberry flea, as it is known to us here in Massachusetts? It is a shiny, scaly bug, about a tenth of an inch long, which perforates the leaves of the growing plants on the margin of the field, and works in towards the centre.

Prof. Lintner. The insect about which inquiry is made is probably one that is properly known as the fly beetle, which not only attacks the leaves of strawberries, but a great many other plants. One excellent preventive of the attack of that insect is sprinkling the plants with dry road dust. Lime is sometimes used for the same purpose. And upon any vegetation where a poisonous insecticide can be applied early in the season, when this attack is made, before the berries have attained to any size, showering with Paris green in water would destroy them.

Mr. O. P. Wilcox of Northborough. Have you ever tried gas tar for the potato beetle?

Prof. Lintner. I do not think that has been tried, for

the reason that we have a most excellent remedy. We need nothing better for that than Paris green, which can be applied without any injury to the potatoes.

Mr. Wilcox. I have tried the gas tar and think it better than Paris green, because it protects against the scabs.

Prof. Lintner. I am very glad to know it is a protection. It only confirms the idea that by the use of proper preventives, the attacks of a great many insects can be guarded against.

Mr. Wilcox. We had the best potatoes of any raised in our neighborhood. Others tried Paris green and we applied gas tar.

Prof. Lintner. May I ask how the gas tar was applied?

Mr. Wilcox. We put say a couple of tablespoonsfuls of gas tar into a gallon of water and apply with a watering-pot.

Prof. Lintner. That is a very excellent remedy for many of our destructive insects.

Mr. Slade. I would like to ask if there is any outward sign or indication by which we can tell where the cut-worm lies, in a cornfield or strawberry bed, without digging for him?

Prof. Lintner. The only indication of the presence of the cut-worm is the yellowing of the plant.

Mr. Slade. Then he does the mischief before we know he is there.

Prof. Lintner. Underground. That is the first evidence of the presence of the cut-worm.

(Mr. E. F. Bowditch of Framingham in the chair.)

GUERNSEY CATTLE IN AMERICA.

BY SILAS BETTS OF CAMDEN, N. J.

About forty-five years ago two or three intelligent gentlemen, residents of the suburbs of Philadelphia, desirous of obtaining the best family cows that could be found in this or any country, were induced to investigate the merits of the Guernseys.

Although Alderney cattle were then but little known beyond the Channel Islands, a few had found their way across the Atlantic.

Nicholas Biddle, president of the United States Bank, purchased the first cow known to be a pure Guernsey, that was ever landed on our shores. She was purchased from the consignees of the schooner Pilot, Capt. Belin, from Guernsey, and cost $500. He never tired in speaking of the merits of this cow and others which he was induced to import. He maintained the herd until his death, as family cows for himself and friends.

Subsequently his son, Judge Craig Biddle, became equally attached to them, and visited the Island of Guernsey, to see the cattle at their original home.

Prof. W. Gibson, an eminent surgeon, connected with the University of Pennsylvania, who owned a country seat near Philadelphia, purchased a black and white Guernsey heifer in 1858. He was a great admirer of fine cattle, and subsequently visited the island and remained there for several months. He visited both islands to learn all he could of both breeds. Prof. Gibson became an enthusiastic admirer of the Guernseys. He wrote glowing descriptions as to their superiority over the Jerseys, and shipped several choice animals for himself and his friend Judge Biddle. Since then they have had a permanent place on these farms. Dr. King and Mr. Fisher have also had them on their farms for over twenty-five years.

Later, the Massachusetts Society for the Promotion of Agriculture introduced Guernseys for the benefit of the farmers of Massachusetts.

Still later, the Fowlers, prominent importers of Channel Island cattle, brought over a few Guernseys with their large importation of Jerseys. The latter were more widely known at this time, and met with a ready sale at prices which encouraged continued importation. The Jerseys largely exceeded the Guernseys on their respective islands, and could be purchased by the importer at moderate prices without such a disturbance of values as would preclude further importations except by a corresponding increase at the ports where they were landed. The Jerseys were sold in Boston, Philadelphia, New York, and at several of the southern ports, thus leading to the formation of numerous herds throughout the country.

The few Guernseys were naturally taken to Philadelphia and Boston, where their merits were not entirely unknown. They sold for about the same prices obtained for the Jerseys. There were no herd-books then, to stimulate prices, nor had there been published any of the marvellous records which have been so skilfully employed since to create booms.

In the meantime the American Jersey Cattle Club was organized, and Col. Waring, an able writer, became its secretary. By his efforts, mainly, the Jerseys were widely advertised through the medium of the agricultural press; he thoroughly popularized the breed, by the extended and continuous publicity which he made of their merits.

The result was increased importations. Wealthy owners of country seats, gentlemen of leisure who had a fondness for the ornamental side of agriculture, suburban residents, and some of the more enterprising farmers, took the fever and joined the eager crowds who attended the auctions of the importers to bid on Jerseys. It was the fashion to own Jerseys, and the prices of the beautiful creatures were pushed very high, regardless of their milking capacity.

Cattle, however, are costly playthings, and then comes a reaction. A large herd will soon eat their way into the bottom of a very deep pocket, unless their milk or butter is sold at a profit. As many of these high-priced beauties were not purchased for their milk, nor for the butter to be sold at a profit, the actual results as investments have proved disappointing to many purchasers. Not because there were wanting splendid butter-makers among them, but on account of a large number of inferior ones, that extreme prices brought over, caused a reaction.

About all the advertising the Guernseys had obtained, up to this time, was gratuitously given by the disappointed purchasers of Jerseys. They wrote numerous letters to the agricultural journals, attempting to show the superiority of the old-fashioned Alderneys over the modern Jerseys; the Guernseys were pointed out as being superior as milkers, and the inexperienced were urged to return to the old type.

This may have influenced the organization of the American Guernsey Cattle Club in 1877.

Up to this period the homelier Guernseys had lived in comparative obscurity. Their original buyers held on to them, and the few cows brought over by the Fowlers remained on the farms of the purchasers. Many of them are there yet. A few old cows continued breeding. Only in a very few instances have entire herds been sold. Once the Guernsey obtains a footing on a farm, she maintains her position.

The Biddles, Fishers and Kings, have the old strains of Guernseys, with fresh blood added. So do all those in Pennsylvania who have selected them for their dairies. Many new owners have been added to the original list. In New Jersey there are a half-dozen herds instead of one, and not one owner in either State has become in any way dissatisfied with them. So far as I am informed, this is the result in all the States where they have been tried.

A part of the increase of the earlier importations have been sold to found other herds. Since the formation of the American Guernsey Cattle Club, importations have been made in large numbers. At the present moment, the number of Guernsey cattle in the country nearly equals the number in Guernsey.

The prices at the few public sales which have occurred recently have receded from the extreme figures obtained when everything was higher. The prevailing depression has affected all values. Many of the cattle offered were either non-breeders or inferior, or so believed. The surplus stock of an old herd is likely to contain too large a percentage of this character. One or two entire herds have been sold below their real value.

The extreme price obtained for a Guernsey at public sale in America was $1,950, two years ago. Previous to that, $650 to $1,000. The average has been about $250 to $300, a price too low to warrant the continued importation of the best on the island. Private importers have paid as high as $1,000 on the island. At private sale the prices obtained are but little lower than in former years. A resident island breeder informs me that the better class of Guernsey cows command as high prices there as ever.

Whatever progress has been made in the numbers and popularity of Guernsey cattle has been accomplished solely on their real merits. They have steadily and surely advanced in numbers. Those people who have once become acquainted with their extraordinary good qualities have never been disappointed. Their good qualities have not been exaggerated.

The advocates of the Guernsey have never made a serious attempt to prove what they believe, that the Guernsey is the best of all the dairy breeds. There are many substantial reasons for this belief; yet a conclusive proof of it, such as would be acknowledged as such by those who have a pecuniary interest in rival breeds, would involve an expense and labor which no breeder of Guernseys has volunteered to assume. Guernseys have been chiefly sought for the money value of their milk and butter, by the dairy farmer; and by private gentlemen who desired their rich milk and excellent butter for their own families.

To test a choice herd of cows for a year, to show what is possible for them to do under good feeding and care, involves not only great expense, but, to make the test creditable to the breed, would require a similar test of other breeds, and thus involve the mutual co-operation of their respective owners. The next best thing to do would be to purchase representative animals, and place them under the supervision of a competent dairyman in some of our State experimental departments. Many who admit that Guernsey milk is higher colored than the milk of other breeds, qualify this admission by hinting that the quantity is deficient. They simply reserve the right to believe that their own chosen breed is equal to or better than the Guernseys in some respects, so they fall back on quantity as a last resort.

I am not here to disparage any breed, but to do justice to the Guernsey. If, in attempting to accomplish this pleasurable task, any damage results to the others, it can be easily and wisely repaired by a change to the Guernsey.

Fifteen years' experience in the use of Guernseys has convinced me that they are the most valuable of all the dairy breeds of which I have any knowledge; and I am therefore certain that their propagation, throughout the dairy sections

of the United States, would add millions of dollars to the value of dairy products.

Their superiority as butter cows is indicated by many facts. Chemical analysis has shown the richness of their milk in butter fat. The average percentage is greater than that of other breeds. This is suggestive, but not conclusive. Butter cannot be made from milk deficient in this element. The quality also depends upon its presence. Logically and reasonably, we may infer that the largest percentage of fat in the milk will make the most butter of the highest quality.

The individual tests of Guernseys for butter have been less numerous than the Jerseys and Holsteins, if we may judge by the published reports.

A large number have been tested with only ordinary feeding and care. Those within my knowledge have ranged from fourteen to twenty-two pounds. There are many Guernseys cows that will make these amounts without experts to feed or train them. A few years ago this would have been regarded as sufficient to recommend any breed. Now such results would only attract a passing notice. This fact may have a restraining influence on those who would otherwise be willing to publish the truth as to the ordinary achievements of their butter cows.

A record of over forty-six pounds of butter in seven days has depressed even the Jersey breeders, and many now, doubtless, wish the amount might have been less.

So much depends upon training and skill in feeding the animal to produce such startling results, that those who rely upon the ordinary, approved methods of feeding are debarred from competing. They must compete with the expert, or with this newly invented science, more than with the cow from which is obtained such wonderful results, — results that have never been paralleled by any dairyman, except he be a modern expert.

A cow that can make only twelve pounds of butter in seven days, when well fed, and having good care, while in the hands of an experienced practical dairyman, one who has spent the best days of his life in the business, has been made to double this amount by extraordinary management. Is she a twelve-pound or a twenty-four-pound cow, for dairy pur-

poses? If resold to her former owner, her value to him will be measured by the twelve-pound weight. Not every breeder is willing to risk the lives of his best cows in order to increase the apparent value of the living.

Two tests of entire herds, consisting of over twenty Guernsey cows, were made during the past year. The cows were fed as usual. All the milk from a single milking of twenty cows was sent to a creamery to be made into butter, in order to determine the price which the manager ought to pay for it. He reported one pound of butter to every five and one-third quarts. The quantity of the milk I did not learn, but the result fixed the price at six cents per quart for butter making.

Quite as many great butter tests, in proportion to the number of cows, have been made in Guernsey as in Jersey, and I have been repeatedly informed that Guernsey butter sells for more, even in Jersey, than their own. Thus quantity and quality are maintained, as might be expected.

In Guernsey, they have recently effected an arrangement to encourage testing, under the supervision of a committee, which includes the secretary of the Royal Guernsey Herd-Book Society. Two tests have been made by this committee. The milk of the first cow weighed 235 lbs., and the butter 13 lbs. $15\frac{3}{4}$ oz. The milk of the second cow weighed 260 lbs. and the butter 17 lbs. $3\frac{3}{4}$ oz. The cows were tethered on grass, and fed between five and six pounds of bran, corn meal, and oil cake, mixed, — moderate feeding. The famous Jersey cow, Coomassie, only made 16 lbs. 11 oz. in Jersey.

It is too early in the history of Guernsey cattle in America to judge them by published yields. Those who have been able to compare them with other breeds in their own dairies, are more than satisfied with their performance at the pail. They are delighted with them.

I started with the intention of keeping Jerseys only; but, during the sale of an importation by one of the Fowlers, I was persuaded by Dr. Zwaddell, an experienced Jersey breeder, to bid on a couple of Guernsey cows, and they proved to be two of the best cows I ever owned. One of them is now living at sixteen years of age and still breeding. I have

sold calves enough from her to pay the original cost a half-dozen times, and her milk has sold for nearly as much as her calves.

I was agreeably surprised to learn, from actual trial, how rich the milk of a good Guernsey cow is. The milk of these two cows perceptibly increased the color of the butter of ten Jerseys. Whereas the color of my butter in the winter previous had been nearly white, it was now tinged with yellow.

I had read in the papers that Jersey butter, in winter, was as yellow as gold. I found, by actual experience, that this could be said of Guernsey butter, without drawing so largely on the imagination. There are Guernsey cows that are not profitable cows. They rarely lack quality, but in some cases the quantity is too small for profit for the milk dairy. They should be slaughtered. I sold one such to the butcher recently, but I sent two of another breed with her. I never sell my poorest cows at auction.

From January 1st to October 1st, 1885, the milk sold from my cows measured 41,848 qts.; there was fed to calves 8,275 qts., and used in two families on the place 1,460 qts., making 51,583 qts. I had thirty milking cows, — twenty Guernseys and ten Jerseys. Two of them were fifteen years old and two had not dropped calves within two years. The period named is for nine months. At the same rate the annual average for every milking cow in the herd would be about 2,290 qts. The actual money received was $3,340 for nine months, a few dollars being charged to loss. If the remaining months do as well, the average receipts for each cow for milk sold will be $149. The price obtained throughout the year is eight cents per quart. In addition to the receipts for milk, calves were sold for $650. The annual receipts for calves for a number of years have averaged nearly $1,000, and quite a number have died of scours and by abortions. No cows are sold except to the butcher.

To raise a calf on my farm to three months of age costs about $50. As some of the bull calves will not bring this sum, in future all the bull calves, except from the choicest cows, will be slaughtered.

By sending to the butcher the inferior cows in my herd, I

can bring up the annual average of milk to 2,500 qts. per cow. If all the milk of the herd, on this basis, was sold at the rate now received, it would amount to an average of $200.

The quality of Guernsey milk is superb. No other, except the Jersey, can compete with it. The Guernseys have an advantage in color. Milk sold from a can of pure Guernsey one day, and to the same customer from a can of pure Jersey the next day, caused complaint, on account of the quality of the latter. This was undoubtedly due to the superior color of the Guernsey. The percentage of cream in either has proved entirely satisfactory.

Guernseys are persistent milkers, as well as large milkers. If regularly and well fed, there will be great difficulty in drying them for a sufficient time for the good of the cow, and the calf which she carries. A good Guernsey is a model family cow. What are the qualities most sought in the family cow? She has been well described by Col. Weld in an article published in several agricultural journals. I quote:

"The family cow is one to be petted. She must be gentle, good-looking, and have such qualities that the wife, and every member of the family, shall be proud of her. Her flow of milk must be generous; the cream thick, abundant, high-colored, and quick in rising. The skim milk may not be too blue; for, notwithstanding all our wise Board of Health say to the contrary, skim milk is, and will be, the milk of the family. Such a cow must be a good feeder, always hungry, not inclined to take on flesh while in milk, and, as a result, will convert all her feed into milk and cream. The butter should be golden, should hold its color well into or through the whole winter, and this product should be so abundant that there shall be no occasion to buy butter so long as the cow is in milk." . . "Besides, she should be an easy milker. The teats should be large enough to be grasped by the whole hand, for, otherwise, more patience and faithfulness will be required in the milker than common family servants, either men or women, usually possess. There, I have described a good Guernsey cow, or a half-bred one, and I very much doubt if such cows can be found in any other breed."

"When we can have, besides plenty of milk, great pitchers full of thick, sweet cream, then we score a point that is of value, and can brag to some purpose. Here is where the Jersey cow comes in, or, rather, the Jersey grade. Besides, the butter is firm and solid, high-colored so long as grass lasts, and of fine flavor if well made. Now, if we would add to this abundance of milk, cream and butter, high color at all seasons, *and on grass intensely high color*, we must go to the Guernseys and their grades."

No more attractive animal can be placed upon a lawn or in the green field. Her rich, yellow, in-curved horns, buff nose, intelligent, mild eyes, warm, orange color, with the yellow skin reflected through the white patch, and the yellow pigment oozing from the skin, fairly staining the white hairs with the same color, — these are qualities that are combined in more Guernsey cattle than any other breed.

The Guernsey cow is the cow for small farms, where beef-making is impracticable because unprofitable. The farmer with few acres can keep only a few cows. They should be good ones, able to produce a steady flow of rich milk for his own use, and a generous surplus that will bring the highest price at his nearest market.

The present tendency in the Far West is to large farms or ranches. Grain-raising and beef-making, and co-operative dairying are made profitable where land is cheap and machinery is largely substituted for labor.

The high-priced lands of the East put a narrower limit to the profitable use of machinery. Less machinery, more labor, and more Guernsey cows are now required on the small farms near Eastern cities. The cows will pay the grocers' bills, enrich the fields, and the labor, if of the right kind, and well directed, will turn everything to profit.

There are over 3,000 Guernseys in America, while there are several millions of dairy cows in these States. The small State of New Jersey has over 160,000 cattle. The great State of New York has over 1,500,000.

Among these are a large number of deep milkers, but only a small number, comparatively, give milk rich in butter fat, — much of this milk is poor for family use or for butter. The average earnings of these cows must be very small,

probably not above $40 per cow, or below the actual cost of keep, not counting the value of their manure. The quality of their product depresses the average price of good milk and butter even more than the artificial butter, for the suppression of which much time, money and labor have been given. The dairy interests are laboring industriously to stop the sale of bogus butter. The consumer is co-operating; but he goes one step further, and demands that skim milk shall be sold under its true colors, and that watered milk shall not be sold. Laws have already been enacted, in several of the States, requiring twelve to thirteen per cent. of solids in milk.

The coming demand for good milk must be met; these millions of cows that give a poor quality of milk should be improved or suppressed. The bulls now in use should be replaced by better animals, that have descended from a good ancestry, distinguished for the qualities which it is desirable to reproduce. A Guernsey bull of good quality, bred to a native cow of large milking capacity, will usually get heifer calves superior to the dams. The bull is fixed in character; he has the blood and qualities of his ancestors. The cow is extremely susceptible to change, having inherited widely varying traits.

Suppose such a cow has ten calves by a bull bred like herself, five of them heifers, how slender the chance of getting one as good. Yet this is the way by which the great multitude of dairy animals have been produced. This is not breeding with a purpose. It is breeding by a lottery, in which the prizes diminish as the tickets increase.

Good Guernsey bulls would convert these cow harems into respectable breeding establishments. Where the motive is simply to get a calf, regardless of quality, there is no room for intelligence. Add to this a desire to get a calf better than its dam, and you will inspire the dullest cow-boy with an ambition. The handling of good stock is in itself an inspiration to a farmer.

It is an old saying that nothing succeeds like success. So it is with any advancement. It is the first step that costs. The grade cattle of my own section have been wonderfully improved in a very few years. I took the first Jerseys into

the western part of the State of New Jersey sixteen years ago, and the first Guernseys a year later. Now, grades of both breeds are found on nearly every farm. No one is satisfied with a family cow unless she has Channel Island blood in her veins. The Guernseys came later, are less in numbers, but their popularity is growing daily.

Why should Guernsey bulls be chosen, in preference to all others, to revolutionize the vast herds of nondescript cows that now indifferently supply our markets with milk and butter?

Bred upon an island, for hundreds of years, where no other cattle are allowed to live, there is no foreign blood in their veins; there is no uncertainty about their purity. The Guernseys have been bred and interbred for generations, strictly for milk, cream and butter. They are milking-machines of a high order; their teats are large, and they are easily milked; they are of good size, and gentle in disposition. Above all, they possess, in a most remarkable degree of any known breed of cattle, that trait so highly prized by all lovers and breeders of fine cattle, which is most comprehensively and tersely expressed by the word Quality.

If they could be generally introduced, or universally substituted for the dairy cows now in use, no experts or chemists would be required to determine the difference between the butter of the farm and the artificial product of the factory.

The common or native cow is usually deficient in quality. Many of them are deficient in quality and quantity. Such should not be bred for the dairy at all; they and their kind belong to the butcher or beef-maker. Any cows that give milk so poor in quality as to expose their owner to arrest for selling impure milk, should have no standing in a milk or butter dairy.

The Guernsey bull should be preferred to the Jersey, because of his size and superior quality, and because his calves are fit for veals: to the Ayrshire for milk and butter, because the Ayrshires are deficient in quality, and have teats so small that it requires an expert to milk them: to the Hols-

teins, because, as a breed, they would be no improvement on the common cow in respect to quality.

As foundation stock, to enable ambitious farmers to create the best of grades, in order to supply the markets with a better dairy product, the Guernsey has not and will not prove anything but a success.

There is always room at the top; and where the top is too near the bottom, the Guernsey will enable an intelligent farmer to move the top upwards. Where there is no profit in a market she will help him to make it.

I do not wish to be understood as arguing that there are no poor, unworthy Guernseys; nor that, in all the breeds, there are not individual animals superior to some Guernseys. To do so would be equivalent to asserting that the perfect cow had already been created. There remains much for her breeders to accomplish. The inferior milkers should be sent to the butcher, and the rest, by careful breeding, will become as famous for quantity as they are now for quality.

As foundation stock for the dairy of the future, I claim that the Guernsey of the present has no equal.

So far, the Guernseys are better known for their high average quality as a breed, than for the phenomenal performance of a few cows under skilful feeding and treatment. This is not singular.

It is only seven years since the first number of the Herd Register of the American Guernsey Cattle Club was issued. Only three years have passed since the island breeders seriously began to keep any breeding records of their cattle, and the first volume of the Royal Guernsey Society's Herd Register was published so recently as 1882.

There was the usual claim of superiority for merit over the average, but no established line of descent from cow to cow, or family to family, could be positively shown. The inheritance of extraordinary merit by one animal, from near relatives, was often known to their owners; yet such a thing as the inheritance of rare excellence, from near and remote ancestors, was only handed down by tradition, — a foundation too slippery for a breeder to rely on. The well-known excellence of the breed was sufficient for the average Guernsey-

man; the parish prizes were the only marks of distinction, and recorded pedigrees were unknown.

As butter cows they bred them and cherished them above all others, and guarded them with jealousy against intermixture with any foreign blood; but the tracing of pedigrees, so that the breeding of one cow or family could be distinguished from others, was never attempted.

The Herd-Book Societies of the island have placed the breeding of Guernseys there on a new basis. We shall now have facts instead of surmises. The missing links in the pedigrees of the breed cannot be restored. New ones as good, or better, can be created.

The new system of testing will furnish to the world definite knowledge as to the superiority of one cow or family over others, and careful records of the breeding, now being made, will make these accessible to the future breeder.

The island breeders having accepted the herd-book methods of the American; now the latter will show equal intelligence by adopting theirs for proving the special merits of particular cows above the average of the breed. This is all that is necessary to give the Guernsey a boom that will place her where she deserves to stand, in the front rank.

It is not the design of this article to discuss systems of breeding, but these brief allusions may be permissible by way of showing the status of the breed at the present time.

As stated, the rule on the island, where there was any deviation from the well-beaten track, has been to breed to prize animals. Doubtless a few have preferred to breed to sires from their best cows. The universal apathy as to recorded pedigrees has rendered such spasmodic efforts of little avail to the breeder of to-day.

The confusion of names, by which one name was transferred for generations to others, perhaps, of entirely different breeding, has been another stumbling-block. Inferior animals bred to others of like quality, and perchance interbred, when this practice was not intended or desired, must have greatly hindered the progress and improvement of the breed.

In no country, except an island, would it have been possible, by such methods, to retain qualities of so high an aver-

age, in a breed of dairy cattle, as is found in the Guernseys. The foundation stock must have been of the rarest.

Now that competition in producing the best of this breed has been extended to England and America, now that herd-book societies exist in all of them, every breeder of Guernseys should adopt some plan for determining for himself the dairy value of his cows, and the herd-book societies should establish a rational system for testing the best; then the possibilities of the breed will begin to create a new interest in the public mind, and new revelations will be made to their most partial advocates.

Mr. Edward Burnett of Southborough. As a Jersey breeder I am very glad to welcome Mr. Betts into our fold. He has made a great many strong points for the Channel Islands cattle, and what he says about the Guernsey cow is very true, although I think he has hardly given credit enough to the Jersey. So far as quality is concerned, — if by "quality" he means simply color, — the Guernsey is superior to any other dairy cow. The Jersey surpasses the Guernsey. I think the best butter in the world would be made by a combination of these two bloods.

We have to-day more tested Jersey cows than Mr. Betts gives us credit for. The whole system of breeding on the island has changed within a few years, and to-day a bull that is the offspring of a cow that has shown a good butter record is sought for. I have visited both the islands three or four times, and I know that the system of breeding is very different on the two islands, and I am not sorry to say that the Jersey farmer shows the most intelligence in breeding. The President of the Royal Agricultural Guernsey Society regretted that so many Guernsey farmers did not take pains to drive their cows to prize bulls, although some of the most magnificent dairy cows in the world are on the island of Guernsey; but breeders there, like our breeders at home, do not pay attention enough to the best blood. I am delighted to welcome Mr. Betts into the ranks of Guernsey breeders who are breeding for butter. Guernsey breeders in this country have bred more from escutcheons than from

butter records. I am enough of a heretic to have very little faith in escutcheons.

About these phenomenal tests: whenever one is mentioned I hear a universal jeer go up. I do not believe in them for the ordinary farmer, but I do believe there are men who will test horses and test cows for the pleasure of the thing, and I believe that they do a great deal of good. I had the honor of making one of the first butter tests ever made with a three-year-old cow, and she produced 21 pounds 11½ ounces in one week. I fed her myself, and she only received about five quarts of grain a day. She had evidently been crammed, because since that time we have learned a great deal about feeding cows for phenomenal tests. You know you have got to train a horse to trot on the track. So you have got to train cows; and to train them you must put them in the hands of an expert. How many farmers who have raised colts ever got a record below three minutes? When a colt makes a record of 2.20 or below, is it not always done by an expert? I say, therefore, that this matter of testing cows is good for the breed and it is good for the farmer. It will show us, and it has shown a great many breeders, the value of breeding from butter bulls the progeny of these great butter cows. Mary Ann of St. Lambert was fed as high as 45 pounds of grain per diem, but she was trained to it. She was driven under a sweat blanket, at a slow walk, three miles a day. I saw her make in one week between 26 and 27 pounds of butter. She was one of the finest-looking cows I ever saw, and she did not show her excessive feed at all, because she was in the hands of an expert. I am a strong advocate of cows that give from 10 to 14 pounds of butter a week. An average of 10 pounds a week for a herd is a magnificent one, and it took Mr. Philip Dannay, the originator of the celebrated Rioter herd, not one year but twenty-five years, to reach an average of 10 pounds with a herd of fifty cows.

I only wanted to say a word about the breeding of cattle, and to make that point about training by experts for big tests. I believe it is legitimate. I have no doubt I shall do it, but I am not anxious at present to make a big test for any of my animals; I am trying to get a high average, rather than a large production from an individual cow.

Allow me to say, that I think the farmers themselves ought to be the best experts on cattle in the world, but too often they allow a five or ten dollar bill to stand in the way of buying a first-rate cow. I have seen it done myself.

Mr. Betts. I quite agree with Mr. Burnett in many points that he makes. I think more intelligence has been displayed by the breeders in Jersey than in Guernsey. The experts in Jerseys have far excelled the experts in Guernseys in this country. But I cannot agree with Mr. Burnett on the question of superior training and feeding. It strikes me that if the dairy business is for farmers, they are the specialists, or should be the specialists, and it seems to me that the dairy business should require no specialist outside of the general dairyman; and when a cow is made to produce, by a man of extraordinary skill, or a man of large capital, what she cannot produce under the guidance of an intelligent man in a dairy, what she produces under such circumstances is not the standard of value, but what she can produce in the dairy is the standard of value.

Mr. Burnett. The man who fed Princess 2nd was a Vermonter; the man who fed Mary St. Lambert was brought up with Lord Elesmere's herd of Shorthorns. Those two men not only fed these cows, but they rubbed them, they examined them, they took their temperature with a thermometer every three hours. I have looked into this thing pretty thoroughly with regard to all our thoroughbred animals, and I find that it is rich men who have taken the different breeds of cattle, horses, swine, sheep, or anything else, and have made them what they are. It is those men who have got money to throw away upon experiments who can do this thing. They have been ably assisted by the farmers. It is a mistaken idea that you must double the quantity of food to double the product of an animal, if she is in the hands of an expert. The best feeders in this country, according to my experience, are the two brothers who live very near Mr. Betts (and I think he will bear me out in the statement), — the Darlington Bros., of West Chester County, Pa. They give their cows eight quarts of clear corn meal a day and just as much chopped-up clover as they want. Those men do not use either thor-

oughbred Jerseys or Guernseys. They go into the market every fall and buy the best cows they can find. They keep those cows along through the winter and just as long as they are paying for themselves; the moment they begin to drop off they are sold to the butcher and their places are filled by others. Those men I call the best feeders anywhere for butter. They make some six hundred pounds a week, and it wholesales to-day at eighty cents a pound and retails at one dollar.

Mr. CHAMBERLAIN. This matter of the best dairy cow is one in which I have been exceedingly interested. It is the husbandry in which I have obtained a livelihood all my life; consequently, it is an important one to me. I am an American; I believe in American men and American women, and I believe in American cows. I am exceedingly obliged to Mr. Burnett for the allusion he has made to the American cow, as developed by the two brothers whom he named. It appears to me that we do not need to describe a Guernsey, or Jersey, or Holstein, or Ayrshire, or Devon, or Shorthorn, any further than this. A Holstein cow, for instance, is the type of a Dutchman. She is large in body, — kind-hearted; she is slow, but she is sure. The Ayrshire is a type of the Scotchman: alert, always wide-awake, strong to produce, willing to live; and her product brings to the owner the largest amount of the most nutritious food, in my judgment, of any animal that we have in America. By far the most practical animal, although not really popular, because simply of the color. Then we have the Durham or Shorthorn, — the type of an Englishman. Well-developed, proud of herself and of all her surroundings, perfectly contented, believing that she is the best cow in the universe, — just like an Englishman, as all the world knows. Then, when we come to the Guernsey and Jersey, what do we say of them? Just like their originators, — Frenchmen. Handsome, fancy, vain. You may say they fill the eye because of the fancifulness of their color and the color of their butter; but really it is not nutritious, — it is not what a hungry man wants, by any means. There is no food value in fat. It may answer the purpose of fuel, to keep the fire going in the system, and perhaps that is a matter of some consequence;

but we can obtain it for a great deal less price than by keeping these high-priced and expensive Jersey or Guernsey cows. It is simply a fancy, but there are always people who have money and are willing to pay it out for fancy; and, to a limited extent, — a very limited one, — we can cater to this fancy for color and make it profitable, but we can by no means think of increasing very largely the Guernsey or Jersey stock in this country as a money-making operation.

What we want is an American cow. What is an American cow? Why, it is just this cow that these brothers buy in the country. I venture to say that they make more money out of the products of their dairy, annually, than any thoroughbred man in this country. These raisers of thoroughbreds get great prices for their animals. We want to come down to the product. In my own neighborhood I am sure it does not pay to keep thoroughbreds. Said one of these breeders to me, not a great while ago: "I will admit that in the sale of your products you make more money than I do, but I sell stock at fancy prices, and I make more money than you or anybody else in the town." But what we want is the product. Now, if one-half or one-third of the energy, capital and thrift which are applied to the raising of thoroughbreds should be applied to the development of American stock, just as we have it now, I believe that they would just as much excel any thoroughbred stock as thoroughbred stock appears now, in certain cases, to excel the present American stock. That is my view of it.

I do not want to go to Scotland, to Guernsey, to Jersey, or to England, but I want to develop the American cow just as it is here. The very best record of a dairy herd that has ever been published in Massachusetts is a record published some twenty-five years ago, I think, of Capt. Bernard's grade stock. I have never seen any record that equalled it. It was a herd of grade cows, bred up from "scrub stock," as they are called, to that very superior condition. I look around me at the butter at the fairs which I visit. We hear about the quality of the butter of Guernsey and Jersey cows, but the butter of such cows does not very

often take the highest premium at our fairs. It was the grade stock of New York and Iowa that took the first premium at the World's Fair. It was grade stock that took the first premium at the Worcester Fair, and it was a grade cow that took the first premium last year at our county fair. I say again, give me the American cow!

Mr. BURNETT. I would like to say a word in reply to Mr. Chamberlain. I am bristling all over with answers to his many questions. I should like to know how he is going to get a grade if we have not any thoroughbreds in this country. In the little island of Jersey, fourteen miles long, for ninety-four years, to be exact, not an animal has been allowed to land on the island. Every animal that is brought there for beef is slaughtered on the docks, under Government inspection. What is the result of that? To-day a thoroughbred Jersey bull will go into a herd of cows and will put his mark on every single cow. One-half of his progeny will look like thoroughbreds. I do not believe in feeding very heavy cows. I would put an Ayrshire bull at the head of your herd, if you want to get milk. They are better than the Holsteins for New England, because they come from a hilly, rugged country, and they will grow fat where a Holstein will starve. The Holsteins at home get a belly full in twice their length, and then lie down and chew their cud.

I would like to say, in opposition to Mr. Chamberlain's position, that perhaps it may be true that the Jerseys and the Guernseys, in the instances that he mentions, have not taken first premiums; but in the towns of Woodstock, Bethel, Pomfret, and scores of other New England towns, the Jerseys and grade Jerseys have taken first premiums. I have never seen a cow in the town of Pomfret, Vt., except a Jersey or grade Jersey, and it is the result of thirty years' work. The farmers of the town of Pomfret get from two to five cents a pound more for their butter, in their market, than the farmers of any other town in the State of Vermont. I get that straight from the Vermont Dairymen's Association. I believe that the farmer has got to have a thoroughbred bull, and the progeny of those males will do him as much good, in many instances, as thoroughbreds. I do not believe

in every farmer keeping thoroughbreds, because thoroughbreds require a great deal of care. There is no question about it. I buy a great many thoroughbred cattle myself, and I know that in many cases those cattle deteriorate, simply for want of care and attention. No thoroughbreds will do without it. The grades do not require quite as much care, although they will pay well for care and attention.

Mr. BETTS. The best herds of American cattle can be found in Texas, and if the gentleman desires a herd of them he can get them very cheap. I believe no animal is too good for an American, no matter where that animal is brought up or bred. It has taken generations to produce these fine dairy animals. No man here is to live for generations, so he cannot expect himself to do the work which has been wrought in two, three or four hundred years. Is it not better to accept some of that work and pay the price for it? It has cost something to produce an animal,—in experience, in intelligence, in money, in years. Now, is it not nonsense for us to refuse to accept these animals? We accept improved architecture in our dwelling-houses, we accept thousands of improvements that are handed down to us; why not accept the good there is in these different breeds of cattle? I would not advocate excessively the Guernseys, although I believe in them thoroughly; but if I could not get them I would take Jerseys.

In illustration of the improvement that has been made in cattle at the West, let me say that any man who buys meat and supplies his family with it can realize this improvement. The beef of this country, especially Western beef, has been revolutionized in the last five years by the Shorthorn and other bulls that have been sent by the carload into Wyoming, Colorado, Dakota and other territories. Butchers and drovers with whom I have talked within the last six months, tell me that better beef is being sent from Dakota now than was sent from Illinois five years ago; and the butchers in my vicinity tell me that they are getting some of the best meat that they ever have had from these Western territories. Now, that has been done by accepting this breed, which was not strictly an American breed; but will

be in time. The Shorthorn, the Devon, the Hereford and the Polled cattle will all be American cattle in a few years. Millions will be added to the value of the beef cattle of our vast western territory by these improvements. So I believe that in time the same improvement will result from the introduction of Jersey, Guernsey and Ayrshire cattle in other places.

Mr. Wheeler. I want to suggest that this herd of the Darlingtons to which allusion has been made is not a representative American herd; it is a selection from all over the country of the best. We all know that in the various breeds there are specially good specimens; and among native cattle, or what we call natives,—which may be grades, the descendants of the original cattle of the country,—there are some very fine specimens; and these gentlemen, who understand their business, perhaps, as well as anybody in the world, use their judgment in making the selections, and they have probably got a better herd of the mixed cattle of the country than can be found anywhere else. There is no question of that. I think the ordinary cattle of the country, known as native cattle, are better represented by the returns which are made. I had the pleasure yesterday morning of looking over some of the agricultural returns which are reported for the year 1885 by the Census Bureau, and I saw that the products of the cows ranged from seventy-eight gallons a year up to eight hundred, very many of them being down to two or three hundred gallons, making an average of perhaps between one and two hundred gallons a year for the cows of Massachusetts. That shows the necessity of improving the breed of cows as they now exist in this State, and the interesting paper to which we have listened this afternoon, I think, will certainly, if it is properly heeded, be of great value in that direction, in improving the dairy products of the farmers of Massachusetts.

Mr. Burnett. I wish to correct the statement which the gentleman made as to the cows in the herd of the Darlington Bros. They told me that they always endeavored to get either grade Jerseys or grade Guernseys for their herd, and they wished they could always get grade Channel Islands cattle for their butter.

Mr. SESSIONS. It is a little peculiar that the friends of any particular breed are able to extract aid and comfort for themselves and their breed out of almost any facts. I was very thankful when the gentleman from Southborough spoke of the Darlington herd, for my information is, that although the Darlington herd is selected without any particular reference to breed, that selection happens to be mostly of grade Shorthorns. Why do they select grade Shorthorns? One reason is because, as the gentleman says, after getting the most out of their cows for a few years that they can, they must come to the final end of all neat stock, which is beef, and a difference of ten, fifteen or twenty dollars in the carcass of a cow, when her usefulness is past, is quite an item.

Then here is another point. The main advantage claimed by the breeders of these fancy dairy cattle, — I do not wish to say a word against them, — is in the quantity and quality of the butter. Now, we have the statement that the Darlingtons, who are at the head of the butter makers of the country in the quality of their product, and who sell it for more money than anybody else, — eighty cents a pound, — make their butter from the grade cows of the country; and I know from gentlemen who have looked over their herd that it is largely composed of grade Shorthorns; not picked out because they are grade Shorthorns, for they do not care what the breed is, but picked out because they happened to come nearest to their standard of a cow, looking at the whole thing, looking at their capacity for feed, their strong constitution, and finally, their value as beef, and taking into consideration, also, the value of the calves.

I do not want to say anything against thoroughbreds of any breed. As the gentleman well says, we can have no grades without we have thoroughbreds first; but there is a demand among the common farmers, among those who have broad acres which they are not able to till with nicety and the perfectness of those near the cities. There must be a breed of cattle for the hills, for the common farmer, and there is an element beyond the quality of butter, and beyond the question of pounds of butter. The common farmer must have something to make his living from. There must be a cow that is worth something for cheese; there must be a

cow that is a good butter cow; there must be a cow from which he can raise steers and heifers for the general market. There are in the State of Massachusetts more cows kept for the production of milk than anything else; there is a larger demand for cows for the production of milk than anything else. Now, the point I wish to make is, that there are more farmers who can with profit keep a cow such as the Darlingtons keep, — a grade cow of good size, well-proportioned, adapted to carry feed, to make the most of it in milk, in beef and in butter, — than any other cow. That is the kind of cow that is needed, and not any fancy breed. There is a place for the fancy breeds, and there are men who will lay out money and time and brains in the production of those breeds; but do not let us forget that there is a world-wide territory beyond us here that wants something else.

Mr. Betts. There is not much danger of our going in the wrong direction, if yours is the right one. There are about 1,500,000 cows, as I said, in the State of New York, and I suppose there are not more than 20,000 or 25,000 of all the thoroughbreds. I would like to ask the gentleman what authority he has for saying that the Darlingtons select Shorthorns for their dairy?

Mr. Sessions. I did not say that they selected Shorthorns as Shorthorns; I said that they selected the type they desired, and that type happened to be the Shorthorn. I understand that their herd is largely composed of grade Shorthorns.

Mr. Betts. I do not understand it to be so, although I do not wish to speak for them.

Mr. Burnett. I speak from personal experience. I visited the herd and they had a few grade Shorthorns but more grade Devons. They were evidently bought with the idea of making good beef after they got through with them.

Secretary Russell. The editor of the next report will submit the question to the Darlington Bros. Meantime, I shall declare this meeting adjourned.

Evening Session.

The attendance in the evening was quite large, and a lecture was delivered by the Secretary of the Board upon "Tropical Vegetation." The Marlboro' Quartette added to the interest and pleasure of the occasion by several lively songs.

Adjourned to Thursday.

THIRD DAY.

The concluding session of the Board began at nine o'clock on Thursday morning, Mr. Bird occupying the chair.

LAWS RELATING TO PUBLIC AND PRIVATE WAYS.

BY BURTON W. POTTER.

Easy and rapid communication between different places is so essential to the development of human progress, that the condition of the roads in a country is a pretty good test of the state of civilization in that country. In this State the various towns and counties are united by such a network of public ways, that nearly every homestead is situated upon a highway, and it can be said with truth that all the roads lead to every important town. New roads are not often required, now, to reach and develop new tracts of land, except in large towns and cities; but they are frequently needed to shorten distances and to improve grades. Consequently the laws relative to the laying out, maintenance and use of highways, are of personal interest to every citizen, and many are also interested in the laws relating to private ways. This must be the justification for your Secretary in asking me to speak upon the subject of the laws relating to public and private ways. I shall state, as briefly and clearly as I can, the laws as they now stand, without trying to explain their origin and the reason thereof.

The public have a right to lay out ways for purposes of business, amusement or recreation, as to markets, to public parks or commons, to places of historic interest or beautiful natural scenery. (11 Allen, 530.) And such ways may be established by prescription, by dedication, or by the acts of the proper public authorities. Twenty years uninterrupted use by the public will make a prescriptive highway. Many of the old roads in our towns and cities have become public thoroughfares by prescriptive use, which began in colonial days, and perhaps then followed Indian trails, or were first used as bridle-paths.

When the owner in fee of land gives to the public a right of passage and repassage over it, and his gift is accepted by the public, the land thus travelled over becomes a way by dedication. The dedication may be made by the writing, the declaration, or by the acts of the owner. It must, however, clearly appear that he intended and has made the dedication, and when it has been accepted by the public it is irrevocable. Formerly it could be accepted by the public by use, or by some act or circumstance showing the town's assent and acquiescence in such dedication; but now no city or town is chargeable for such dedicated way until it has been laid out and established in the manner provided by the statutes. (Pub. Stat., chap. 49, sect. 94.) It was formerly thought that this act applied to prescriptive ways as well as to dedicated ways (16 Gray, 228); but it is now settled that it applies only to ways by dedication, and ways by prescription are not affected by it. (128 Mass. 63.) The proper town or city authorities have jurisdiction to lay out or alter ways within the limits of their respective cities or towns, and to order specific repairs thereon. (Pub. Stat., chap. 49.) The county commissioners have also jurisdiction to lay out public ways, the termini of which are exclusively within the same town; and they are also clothed with authority to lay them out from town to town. Hence roads may be either town ways or public highways. When the proceedings for their location originate with the town or city officials they are town ways, and when the proceedings originate with the county commissioners they are public highways. (7 Cush. 394.) Suppose a new road is wanted,

or an alteration in an old one is desired, within the limits of a town, a petition therefor may be presented either to the town authorities or to the county commissioners. If the proposed road is not situated entirely within the limits of one town or city, then the commissioners alone have jurisdiction in the premises. When the selectmen or road commissioners of a town decide to lay out a new road, or to alter an old one, their doings must be reported and allowed at some public meeting of the inhabitants regularly warned and notified therefor; but while the inhabitants are vested with the right of approval, they have no right to vote that the selectmen or road commissioners shall lay out a particular way, as it is the intention of the statute that these officials shall exercise their own discretion upon the subject. (5 Pick. 492.) If the town authorities unreasonably refuse or neglect to lay out a way, or if the town unreasonably refuses or delays to approve and allow such way as laid out or altered by its officials, then the parties aggrieved thereby may, at any time within one year, apply to the county commissioners, who have authority to cause such way to be laid out or altered. But when a petition for a public way is presented in the first instance to the county commissioners, or when the matter is brought before them by way of appeal, their decision on the question of the public necessity and convenience of such way is final, and from which there is no appeal. If damage is sustained by any person in his property by the laying out, alteration or discontinuance of a public way, he is entitled to receive just and adequate damages therefor, to be assessed, in the first place, by the town or city authorities or by the county commissioners, and, finally, by a jury, in case one is demanded by him. He is entitled to a reasonable time to take off any timber, wood or trees, which may be upon the land to be taken; but if he does not remove the same within the time allowed, he is deemed to have relinquished his right thereto. In estimating the damage to the landowner, caused by the laying out or the alteration of a public way over his land, neither the city nor town authorities, nor a jury, are confined to the value of the land taken. He is also entitled to the amount of the damage done to his remaining land by such laying out or alteration. (14 Gray,

214.) But in such estimation of damages any direct or peculiar benefit or increase of value, accruing to his adjoining land, is to be allowed as a betterment, by way of set-off; but not any general benefit or increase of value received by him in common with other land in the neighborhood. (4 Cush. 291.)

The cost of making and altering ways, including damages caused thereby, is to be paid by the city or town wherein the same are located, provided the proceedings originate with the town or city authorities; but when the proceedings originate with the county commissioners, they divide the cost between towns and the county in such manner as they think to be just and reasonable. (6 Met. 329.)

Repairs.

After highways, town-ways, streets, causeways and bridges have been established, they are to be kept in such repair as to be reasonably safe and convenient for travellers at all seasons of the year at the expense of the town or city in which they are situated. (Pub. Stat., chap. 52.)

It is the duty of each town to grant and vote such sums of money as are necessary for repairing the public ways within its borders; and if it fails to do so, the highway surveyors, in their respective districts, may employ persons, as directed in the statutes, to repair the roads, and the persons so employed may collect pay for their labor of the town. In order to make such repairs, city and town authorities may select and lay out land within their respective limits as gravel and clay pits from which may be taken earth and gravel necessary for the construction and repairs of streets and ways. (Pub. Stat., chap. 49, sect. 99.) And they may turn the surface drainage of the roads upon the land of the adjoining owners without liability. (13 Gray, 601.) But no highway surveyor has a right, without the written approbation of the selectmen, to cause a watercourse, occasioned by the wash of the road, to be so conveyed by the roadside as to incommode a house, a store, shop or other building, or to obstruct a person in the prosecution of his business. (Pub. Stat., chap. 52, sect. 12.) Properly authorized city or town officers may trim or lop off trees and bushes standing in the public ways, or cut down

and remove such trees; and may cause to be dug up and removed whatever obstructs such ways, or endangers, hinders or incommodes persons travelling therein. (Stat. 1885, chap. 123.) Even the boundaries of public ways are so well guarded that when they are ascertainable no length of time less than forty years justifies the continuance of a fence or building within their limits; but the same may, upon the presentment of a grand jury, be removed as a nuisance. (Pub. Stat., chap. 54.)

It is so important that the public ways be kept free for travel, that any person may take down and remove gates, rails, bars or fences, upon or across highways, unless the same have been there placed for the purpose of preventing the spreading of a disease dangerous to the public health, or have been erected or continued by the license of the selectmen or county commissioners. (Pub. Stat., chap. 54.) A highway surveyor acting within the scope of his authority may dig up and remove the soil within the limits of the public ways for the purpose of repairing the same, and may carry it from one part of the town to another. (125 Mass. 216.) And he has a right to deposit the soil thus removed on his own land, if that is the best way of clearing the road of useless material. (128 Mass. 546.)

Though the law is imperative that the roads must be kept in good condition, and to this end gives municipal corporations great powers, yet let no one, who is not a highway surveyor, or in his employ, imagine that he can repair a road not on his own land with impunity; for it has been decided that, if an unauthorized person digs up the soil on the roadside by another person's land for the purpose of repairing the road, he is a trespasser and liable for damages, although he does only what a highway surveyor might properly do. (8 Allen, 473.) It is also the duty of cities and towns to guard with sufficient and suitable railings every road which passes over a bank, bridge, or along a precipice, excavation or deep water; and it makes no difference whether these dangerous places are within or without the limits of the road, if they are so imminent to the line of public travel as to expose travellers to unusual hazard. (13 Allen, 429.) But towns are not obliged to put up railings merely to prevent travellers from

straying out of the highway, where there is no unsafe place immediately contiguous to the way. (122 Mass. 389.)

The roads are for the use of travellers, and a city or town is not bound to keep up railings strong enough for idlers to lounge against or children to play upon. (3 Allen, 374; 8 Allen, 237.)

The travelled parts of all roads ought to be wide enough to allow of the ordinary shyings and frights of horses with safety, for shying is one of the natural habits of the animal. (100 Mass. 49.) Although it seems that switching his tail over the reins is not a natural habit of the animal, as it has been decided that if a horse throws his tail over the reins and thereby a defect in the road is run against, no damages can be recovered. (98 Mass. 578.)

Guide-posts.

The statutes undertake to provide for the erection and maintenance of guide-posts at suitable places on the public ways; but one has to travel but little in many of the towns of the State to come to the conclusion that the law is either deficient in construction or a dead letter in execution. The law makes it incumbent upon the selectmen or road commissioners of each town to submit to the inhabitants, at every annual meeting, a report of all the places in which guide-posts are erected and maintained within the town, and of all places at which, in their opinion, they ought to be erected and maintained. For each neglect or refusal to make such report they shall severally forfeit ten dollars. After the report is made the town shall determine the several places at which guide-posts shall be erected and maintained, which shall be recorded in the town records. A town which neglects or refuses to determine such places, and to cause a record thereof to be made, shall forfeit five dollars for every month during which it neglects or refuses to do so.

At each of the places determined by the town there shall be erected, unless the town at the annual meeting agrees upon some suitable substitute therefor, a substantial post of not less than eight feet in height, near the upper end of which shall be placed a board or boards, with plain inscription

thereon, directing travellers to the next town or towns and informing them of the distance thereto.

Every town which neglects or refuses to erect and maintain such guide-posts, or some suitable substitutes therefor, shall forfeit, annually, five dollars for every guide post which it neglects or refuses to maintain. (Pub. Stat., chap. 53, sects. 1–5.) These forfeitures can be recovered either by indictment or by an action of tort for the benefit of the county wherein the acts of negligence or refusal occur, and any interested or public-spirited person can make complaint of such negligence or refusal to the superior court, or to any trial justice, police, district or municipal court having jurisdiction of the matter. (Pub. Stat., chap. 217 ; 108 Mass. 140.)

Shade Trees, Parks and Commons.

The law of the Commonwealth not only requires the public ways to be kept safe and convenient, but, of late years, statutes have been passed allowing owners of land, improvement societies, cities and towns, to do something to beautify the roadsides and public squares of any city or town. A city or town may grant or vote a sum not exceeding fifty cents for each of its ratable polls in the preceding year, to be expended in planting, or encouraging the planting by the owners of adjoining real estate, of shade trees upon the public squares or highways. (Stat. 1885, chap. 123.) Such trees may be planted wherever it will not interfere with the public travel or with private rights, and they shall be deemed and taken to be the private property of the person so planting them or upon whose premises they stand. (Pub. Stat., chap. 54, sect. 6.)

Improvement societies, properly organized for the purpose of improving and ornamenting the streets and public squares of any city or town by planting and cultivating ornamental trees therein, may be authorized by any town to use, take care of, and control the public grounds or open spaces in any of its public ways, not needed for public travel. They may grade, drain, curb, set out shade or ornamental trees, lay out flower plots, and otherwise improve the same ; and may protect their work by suitable fences or railings, subject to such directions as may be given by the selectmen or road commis-

sioners. And any person who wantonly, maliciously or mischievously drives cattle, horses or other animals, or drives teams, carriages or other vehicles, on or across such grounds or open spaces, or removes or destroys any fence or railing on the same, or plays ball or other games thereon, or otherwise interferes with or damages the work of such corporation, is subject to a fine not exceeding twenty dollars for each offence, for the benefit of the society. (Stat. 1885, chap. 157.)

It is also a legal offence for any one to wantonly injure or deface a shade tree, shrub, rose, or other plant or fixture of ornament or utility in a street, road, square, court, park or public garden, or to carelessly suffer a horse or other beast driven by or for him, or a beast belonging to him and lawfully on the highway, to break down or injure a tree, not his own, standing for use or ornament on said highway. (Pub. Stat., chap. 54, sects. 7, 8.) And no one, even if he be the owner of the land, has the right to cut down or remove an ornamental or shade tree standing in a public way, without first giving notice of his intention to the municipal authorities, who are entitled to ten days to decide whether the tree can be removed or not. And whoever cuts down or removes or injures such tree in violation of the law, shall forfeit not less than five nor more than one hundred dollars for the benefit of the city or town wherein the same stands. (Pub. Stat., chap. 54, sects. 10, 11.)

Drinking Troughs and Fountains.

The selectmen may establish and maintain such drinking troughs, wells and fountains within the public highways, squares and commons of their respective towns, as in their judgment the public necessity and convenience may require, and the towns may vote money to defray the expenses thereof. (Pub. Stat., chap. 27, sect. 50.) But the vote of a town instructing the selectmen to establish a watering trough at a particular place would be irregular and void, because towns in their corporate capacity have not been given the right by statute to construct drinking troughs in the public highways. And towns would not be liable for the acts of the selectmen performed in pursuance of this

statute, because the law makes the selectmen a board of public officers, representing the general public, and not the agents of their respective towns. However, if the inhabitants of a town should construct a drinking trough or fountain of such hideous shape, and paint it with such brilliant color, that it would frighten an ordinarily gentle and well-broken horse, by reason of which a traveller should be brought in contact with a defect in the way or on the side of the way, and thus injured, the town might be held liable to pay damages. (125 Mass. 526.) It is my purpose to state what the law is, and not what it ought to be, but I will venture the suggestion that it would not be an unreasonable hardship on towns to require them to establish and maintain suitable watering troughs at suitable places, and it would be a merciful kindness to many horses which now frequently have to travel long distances over dusty roads in summer heat without a chance to get a swallow of water from a public drinking trough.

Public Use of Highways.

After the roads are ready for use and beautified by shade trees and green parks at convenient places, we are confronted with the question: How are they to be used by the public and the owners of adjoining estates? We, as a people, are not only continental and terrestrial travellers, but we are continually passing hither and thither over the public ways of this State, and, consequently, it is important for us to know how to travel the common roads in a legal and proper manner. In the first place, every one who travels upon a public thoroughfare is bound to drive with due care and discretion, and to have an ordinarily gentle and well-trained horse, with harness and vehicle in good roadworthy condition, as he is liable for whatever damages may be occasioned by any insufficiency in this respect. (4 Gray, 178.)

Another duty which every traveller is bound to observe, is to drive at a moderate rate of speed. To drive a carriage or other vehicle on a public way at such a rate or in such a manner as to endanger the safety of other travellers, or the inhabitants along the road, is an indictable offence at com-

mon law and amounts to a breach of the peace; and in case any one is injured or damaged thereby, he may look to the fast driver for his recompense. But it does not follow that a man may not drive a well-bred and high-spirited horse at a rapid gait, if does not thereby violate any ordinance or by-law of a town or city; for it has been held that it cannot be said, as matter of law, that a man is negligent, who drives a high-spirited and lively-stepping horse at the rate of ten miles an hour in a dark night. (8 Allen, 522.)

It then behooves every one to drive with care and caution, whether he is going fast or slow; and it also behooves him to see that his servants drive with equal care and caution, for he is responsible to third persons for the negligence of his servants, in the scope of their employment, to the same extent as if the act were his own, although the servants disobey his express orders. If you send your servant upon the road with a team, with instructions to drive carefully and to avoid coming in contact with any carriage, but instead of driving carefully he drives carelessly against a carriage, you are liable for all damages resulting from the collision; and if the servant acts wantonly or mischievously, causing thereby additional bodily or mental injury, such wantonness or mischief will enhance the damage against you. (3 Cush. 300; 114 Mass. 518.)

You may think this a hard law, but it is not so hard as it would be, if it allowed you to hire ignorant, wilful and incompetent servants, to go upon the road and injure the lives and property of innocent people without redress, save against the servants, who, perchance, might be financially irresponsible. It should, however, be stated, in this connection, that if your team should get away from you or your servant, without any fault on your or his part, and should run away and do great damage, by colliding with other teams, or by running over people on foot, you would not be held responsible, as in law it would be regarded as an inevitable accident. Thus, if your horse should get scared by some sudden noise, or frightful object by the wayside, or through his natural viciousness of which you were ignorant, or by some means should get unhitched after you had left him securely tied, and in consequence

thereof should plunge the shaft of your wagon into some other man's horse, or should knock down and injure a dozen people, you would not be liable, because the injury resulted from circumstances over which you had no control. (1 Addison on Torts, 466.)

The Law of the Road.

There are certain rules applicable to travellers upon public ways, which are so important that everybody ought to know and observe them. The law relative thereto is known as the law of the road. These rules relate to the meeting, passing, and conduct of teams on the road, and it is more important that there should be some well established and understood rules on the subject than what the rules are. In England the rules are somewhat different, and some of them are the reverse of what they are in this country. But the rules and the law relating thereto in this country are about the same in every State of the Union. Our statutes provide that, when persons meet each other on a bridge or road, travelling with carriages or other vehicles, each person shall seasonably drive his carriage or other vehicle to the right of the middle of the travelled part of such bridge or road, so that their respective carriages or other vehicles may pass each other without interference: that one party passing another going in the same direction must do so on the left hand side of the middle of the road, and if there is room enough, the foremost driver must not wilfully obstruct the road. (Pub. Stat., chap. 93.)

Although these are statutory rules, yet they are not inflexible in every instance, as on proper occasions they may be waived or reversed. They are intended for the use of an intelligent and civilized people, and, in the crowded streets of villages and cities, situations or circumstances may frequently arise when a deviation will not only be justifiable but absolutely necessary. One may always pass on the left side of a road, or across it, for the purpose of stopping on that side, if he can do so without interrupting or obstructing a person lawfully passing on the other side. (Angell on Highways, sect. 336.) And if the driver of a carriage on the proper side of the road sees a horse coming furiously on the wrong side of the road, it is his duty to give way and go

upon the wrong side of the road, if by so doing he can avoid an accident. (Shearman & Redfield on Negligence, sect. 309.) But in deviating from the law of the road, one must be able to show that it was the proper and reasonable thing to do under the circumstances, or else he will be answerable for all damages; for the law presumes that a party who is violating an established rule of travelling is a wrongdoer. (100 Mass. 313; 121 Mass. 216.) Of course a person on the right side of the road has no right to run purposely or recklessly into a trespasser, simply because he has wrongfully given him the opportunity to receive an injury, and then turn round and sue for damages arising from his own foolhardiness and devil-may-care conduct. (12 Met. 415.)

Every one seeking redress at law on account of an accident must be able to show that he himself was at the time in the exercise of ordinary care and precaution, and it is not enough for him to show that somebody else was violating a rule of law. (121 Mass. 216.) When the road is unoccupied a traveller is at liberty to take whichever side of the road best suits his convenience, as he is only required "seasonably to drive to the right" when he meets another traveller; but if parties meet *on the sudden*, and an injury results, the party on the wrong side of the road is responsible, unless it clearly appears that the party on the proper side has ample means and opportunity to prevent it. (10 Cush. 495; 3 Carr & Payne, 554; Angell on Carriers, sect. 555.)

When there is occasion for one driver to pass another going in the same direction, the foremost driver may keep the even tenor of his way in the middle or on either side of the road, provided there is sufficient room for the rear driver to pass by; but if there is not sufficient room, it is the duty of the foremost driver to afford it, by yielding an equal share of the road, if that be practicable; but if not, then the object must be deferred till the parties arrive at ground more favorable to its accomplishment. If the leading traveller then wilfully refuses to comply, he makes himself liable, criminally, to the penalty imposed by the statute, and answerable at law in case the rear traveller suffers damage in consequence of the delay. There being no statute regulations as to the manner in which persons should drive when they meet at the junction

of two streets, the rule of the common law applies, and each person is bound to use due and reasonable care, adapted to the circumstances and place. (12 Allen, 84.)

By the "travelled part" of the road is intended that part which is usually wrought for travelling, and not any track which may happen to be made in the road by the passing of vehicles; but when the wrought part of the road is hidden by the snow, and a path is beaten and travelled on the side of the wrought part, persons meeting on such beaten and travelled path are required to drive their vehicles to the right of the middle of such path. (4 Pick. 125; 8 Met. 213.) Many drivers of heavily loaded vehicles seem to think that all lightly loaded ones should turn out and give them all the travelled part of the road. No doubt a lightly loaded vehicle can often turn out with less inconvenience than a heavily loaded one, and generally every thoughtful and considerate driver of a light vehicle is willing to, and does, give the heavy vehicle more than half the road, on every proper occasion; but the driver of the heavy vehicle ought to understand that it is done out of courtesy to himself and consideration for his horses, and not because it is required by any rule of law. The statute law of the road in this State makes no distinction between the lightly and the heavily loaded vehicle. Both alike are required to pass to the right of the travelled part of the road. In case of accident the court would undoubtedly take into consideration the size and load of each vehicle, as bearing upon the question of the conduct of the drivers under the circumstances, and their responsibility would be settled in accordance with "the law of the road," modified and possibly reversed by the situation of the parties and the circumstances surrounding them at the time. (111 Mass. 360)

A traveller in a common carriage may use the track of a street railway when the same is not in use by the company, but the company is entitled to the unrestricted use of their rails upon all proper occasions, and then such traveller must keep off their track or else he renders himself liable to indictment under the statutes of the State. (Pub. Stat., chap. 113, sect. 37; 7 Allen, 573.)

EQUESTRIANS.

In England "the law of the road" applies as well to equestrians as to travellers by carriage, and I can see no good reason why it should not do so here. The statutes are silent on the subject, and I cannot find that our supreme court has ever had occasion to pass upon the question; but it has been decided in some of the States, that when a traveller on horseback meets another equestrian, or a carriage, he may exercise his own notions of prudence and turn either to the right or to the left at his option. (24 Wend. 465.) By common consent and immemorial usage an equestrian is expected to yield the road, or a good share of it, to a wagon or other vehicle. It has been decided in Pennsylvania that if he has a chance to turn out and refuses to do so, and his steed or himself is injured by a collision, he is remediless. (23 Penn. Stat. 196.)

It is clear that the statute law of the road in this State is not applicable to people on horseback, as it is expressly limited to carriages or other vehicles, and therefore equestrians are amenable only to the common law of the land. By this law they are required to ride on the public ways with due care and precaution, and to exercise reasonably good judgment on every occasion, under all the attendant circumstances. When they meet wagons, whether heavily loaded or not, they ought to yield as much of the road as they can conveniently, — certainly more than half, as they do not need that much of the road to pass conveniently, — but when they meet a vehicle in the form of a bicycle there seems to be no good reason why they should yield more than half the road. For the convenience of themselves and the public at large, on meeting vehicles or each other, they ought to pass to the right, as by adopting the statute law of the road in this respect order is promoted and confusion avoided.

PEDESTRIANS.

A public thoroughfare is a way for foot-passengers as well as carriages, and a person has a right to walk on the carriage-way if he pleases; but as Chief Justice Denman

once remarked: "He had better not, especially at night, when carriages are passing along." (5 Carr & P. 407.) However, all persons have an undoubted right to walk on the beaten track of a road, if it has no sidewalk, even if infirm with age or disease, and are entitled to the exercise of reasonable care on the part of persons driving vehicles along it. If there is a sidewalk which is in bad condition, or obstructed by merchandise or otherwise, then the foot-passenger has a right to walk on the road if he pleases. But it should be borne in mind that what is proper on a country road, might not be in the crowded streets of a city. In law every one is bound to regulate his conduct to meet the situations in which he is placed, and the circumstances around him at the time. A person infirm with age or disease, or afflicted with poor eyesight, should always take extraordinary precaution in walking upon the road. (1 Allen, 180.) Thus, a man who traverses a crowded thoroughfare with edged tools or bars of iron, must take especial care that he does not cut or bruise others with the things he carries. Such a person would be bound to keep a better lookout than the man who merely carried an umbrella; and the man who carried an umbrella would be bound to take more care walking with it than a person who had nothing. (1 Addison on Torts, sect. 480.)

Foot men have a right to cross a highway on every proper occasion, but when convenient they should pass upon cross-walks, and in so doing should look out for teams; for it is as much their duty, on crossing a road, to look out for teams, as it is the duty of the drivers of teams to be vigilant in not running over them. The law of the road as to the meeting of vehicles does not apply to them. They may walk upon whichever side they please, and turn, upon meeting teams, either to the right or the left, at their option, but it is their duty to yield the road to such an extent as necessary and reasonable; and, if they walk in the beaten track, or cross it, when teams are passing along, they must use extraordinary care and caution or they will be remediless in case of injury to themselves. They may travel on the Lord's day for all purposes of necessity or charity; and they may also take short walks in the public highway on Sundays, simply

for exercise and to take the air, and even to call to see friends on such walks, without liability to punishment therefor under the statutes for the observance of the Lord's day, and they can recover damages for injuries wrongfully sustained while so walking. (14 Allen, 475; Barker *v.* Worcester, 139 Mass. 74.)

By a comparatively recent statute towns and cities have authority to lay out foot-paths in the same manner as public ways. (Pub. Stat., chap. 49, sect. 83.) It is to be hoped ere long that the intelligent and public-spirited citizens of some of our towns and cities will avail themselves of the provisions of this statute, and cause, now and then, a good footwalk to be constructed, where it would shorten the distance from one place to another, and, possibly, pass through pleasant fields and woods, and over hills commanding beautiful and extensive views. It is not pleasant walking in the dust and publicity of highways, nor on gravel walks in artificial parks, where signboards and policemen warn you frequently to "keep off the grass."

Genuine lovers of nature and rural scenes love to feel the grass beneath their feet. Good foot-paths would furnish an easy and convenient way of getting at nature; and, being free from the dust and heat of the highway, and somewhat retired and secluded, they would be, during a considerable portion of the year, musical with the song of birds and beautiful with green foliage and lovely flowers. These paths would invite and encourage people to take long walks, and this habit would undoubtedly conduce to their longevity and robust health. And the promotion of health is now regarded, in every enlightened community, as one of the objects of goverment. The enjoyment of life depends in great measure upon the state of our health. When the air feels bracing, and food and drink taste sweet to us, much else in life tastes sweet which would otherwise taste sour and disagreeable. Good drainage and vaccination are not the only means available for the promotion of the public health. People should be encouraged and educated into the habit of taking plenty of exercise in the open air, as in this way the public health will be improved.

Before our towns and cities spend any more money build-

ing boulevards and opening new parks, would it not be well for them to consider the advisability of laying out some foot-paths for the comfort and convenience of pedestrians? At any rate, foot-paths could be made alongside of the roadbed of some of the public ways, so that every pedestrian would not of necessity have to trudge along in the dust or mud incident to the middle of the road.

Omnibuses, Stages and Horse Cars.

Nearly every one has occasion, more or less often, to travel over the public ways in the coaches of passenger carriers. Whoever undertakes to carry passengers and their baggage for hire from place to place, is bound to use the utmost care and diligence in providing safe and suitable coaches, harnesses, horses and coachmen, in order to prevent such injuries as human care and foresight can guard against.

If an accident happens from a defect in the coach or harness which might have been discovered and remedied upon careful and thorough examination, such accident must be ascribed to negligence, for which the owner is liable, in case of injury to a passenger happening by reason of such accident.

On the other hand, where the accident arises from a hidden and internal defect, which careful and thorough examination would not disclose, and which could not be guarded against by the exercise of sound judgment and the most vigilant oversight, then the proprietor is not liable for the injury, but the misfortune must be borne by the sufferer as one of that class of injuries for which the law can afford no redress in the form of a pecuniary recompense.

If a passenger, in peril arising from an accident for which the proprietors are responsible, is in so dangerous a situation as to render his leaping from the coach an act of reasonable precaution, and he leaps therefrom and breaks a limb, the proprietors are answerable to him in damages, though he might safely have retained his seat. (9 Met. 1.)

When the proprietors of stages or street-car coaches, which are already full and overloaded, stop their coaches, whether at the signal or not of would-be passengers, and open the

doors for their entrance, they must be considered as inviting them to ride, and thereby assuring them that their passage will be a safe one, at least so far as dependent upon the exercise of reasonable and ordinary care, diligence and skill, on their part, in driving and managing their horses and coaches; and, in fact, they are rather to be held responsible for such increased watchfulness and solicitous care, skill and attention, as the crowded condition of the vehicle requires. If, under such circumstances, a passenger is thrown out of or off the coach by its violent jerk at starting or stopping, or in any other way through the negligence of the proprietors or their agents, he may hold them liable for his injuries. (103 Mass. 391.) A passenger must pay his fare in advance, if demanded, otherwise he may have to pay a fine for evading fare; and if he is riding free, the proprietors are not responsible, except for gross negligence; and he must also properly and securely pack his baggage, if he expects to recover damages in case of loss. A mail-coach is protected by act of Congress from obstructions, but is subject in all other respects to the law of the road. (1 Watts (Pa.), 360.)

If the proprietors of coaches used for the common carriage of persons are guilty of gross carelessness or neglect in the conduct and management of the same while in such use, they are liable to a fine not exceeding five thousand dollars, or to imprisonment not exceeding three years. (Pub. Stat. 202, sect. 34.) And if a driver of a stage-coach or other vehicle for the conveyance of passengers for hire, when a passenger is within or upon such coach or vehicle, leaves the horses thereof without some suitable person to take the charge and guidance of them, or without fastening them in a safe and prudent manner, he may be imprisoned two months or fined fifty dollars. (Pub. Stat. 202, sect. 35.)

Purposes for which Highways may be Used.

As before intimated, the public ways are mainly for the use of travellers, but in the progress of civilization it has become convenient and necessary to use them for other purposes of a public nature. It is the great merit of the common law, that while its fundamental principles remain fixed from generation to generation, yet they are generally so

comprehensive and so well adapted to new institutions and conditions of society, new modes of commerce, new usages and practices, that they are capable of application to every phase of society and business life. Time and necessity, as well as locality, are important elements in determining the character of any particular use of a public way. (35 N. H. 257.) Many public ways are now used for gas, water-pipes and sewers, because the public health and convenience are subserved by such use. They are also used for the transmission of intelligence by electricity, and the post-boy and the mail-coach are disappearing.

The horse railroad was deemed a new invention, but it was held that a portion of the road might well be set aside for it, although the rights of other travellers, to some extent, were limited by the privileges necessary for its use. (136 Mass. 75.)

And now motor cars and elevated railroads are making their appearance in the centres of civilized life, and the bicycle and the tricycle are familiar objects on all the great thoroughfares. Should human ingenuity discover any new modes of conveying persons and property over the public ways, or of transmitting intelligence along the same, which should prove convenient to the everyday life of humanity, no doubt the highway law will be found applicable to all the needs of advancing civilization. The underlying principle of the law is that every person may use the highway to his own best advantage, but with a just regard to the like rights of others. The law does not specify what kind of animals or vehicles are to be allowed upon the road, but leaves every case to be decided as it shall arise, in view of the customs and necessities of the people from time to time. All persons may lawfully travel upon the public ways with any animal or vehicle which is suitable for a way prepared and intended to afford the usual and reasonable accommodations needful to the requirements of a people in their present state of civilization; but if any person undertakes to use or travel upon the highway in an unusual or extraordinary manner, or with animals, vehicles or freight not suitable or adapted to a way opened and prepared for the public use, in the common intercourse of society, and in the transaction of usual and

ordinary business, he then takes every possible risk of loss and damage upon himself. (14 Gray, 242.)

If a party leads a bull or other animal through a public way without properly guarding and restraining the same, and for want of such care and restraint people rightfully on the way and using due care are injured, the owner of the animal is responsible, because under such circumstances he is bound to use the utmost care and diligence, especially in villages and cities, to avoid injuries to people on the road. (106 Mass. 281; 126 Mass. 506.) So, if a man goes upon the highway with a vehicle of such peculiar and unusual construction, or which is operated in such a manner, as to frighten horses and to create noise and confusion on the road, he is guilty of an indictable offence and answerable in damages besides. A yclept velocipede in the road has been held in Canada to be a nuisance, and its owner was indicted and found guilty of a criminal offence. (30 Q. B. Ont. 41.) In England a man who had taken a traction steam-engine upon the road, was held liable to a party who had suffered damages by reason of his horses being frightened by it. (2 F. & F. 229.) It has been held to be a nuisance at common law to carry an unreasonable weight on a highway with an unusual number of horses. (3 Salk. 183); and so it is a nuisance for a large number of persons to assemble on or near a highway for the purpose of shouting and making a noise and disturbance; and likewise it is a nuisance for one to make a large collection of tubs in the road, or to blockade the way by a large number of logs, cattle or wagons; for, as Lord Ellenborough once said, the king's highway is not to be used as a stable or lumber yard.

Towns and cities have authority to make by-laws regulating the use and management of the public ways within their respective limits, not repugnant to law, as they shall judge to be most conducive to their welfare. (Pub. Stat., chap. 27, sect. 15; Pub. Stat., chap. 53; 97 Mass. 221.) They may make such by-laws to secure, among other things, the removal of snow and ice from sidewalks by the owners of adjoining estates; to prevent the pasturing of cattle or other animals in the highways; to regulate the driving of sheep, swine and neat cattle over the public ways; to regulate the

transportation of the offal of slaughtered cattle, sheep, hogs and other animals along the roads; to prohibit fast driving or riding on the highways; to regulate travel over bridges; to regulate the passage of carriages or other vehicles, and sleds used for coasting, over the public ways; to regulate and control itinerant musicians who frequent the streets and public places; and to regulate the moving of buildings in the highways. Many people are inclined to make the highway the receptacle for the surplus stones and rubbish around their premises, and to use the wayside for a lumber and wood yard. And some farmers are in the habit of supplying their hog-pens and barn cellars with loam and soil dug out of the highway.

Again, some highway surveyors have very little taste for rural beauty, and show very poor judgment, and perhaps now and then a little spite, in ploughing up the green grass by the roadside, and sometimes in front of houses. These evils can be remedied by every town which will pass suitable by-laws upon the subject and see that they are enforced. Such by-laws might provide that no one should be allowed to deposit within the limits of the highway any stones, brush, wood, rubbish or other substance inconvenient to public travel; that no one should be permitted to dig up and carry away any loam or soil within the limits of the highway; and that no highway surveyor should be allowed to dig or plough up the greensward in front of any dwelling-house, or other building used in connection therewith, without the written direction or consent of the selectmen.

Use of Highways by adjoining Owners.

The owner of land adjoining a highway ordinarily owns to the middle of the road, and while he has the same rights as the public therein, he also has, in addition thereto, certain other rights incident to the ownership of the land over which the road passes. When land is taken for a highway, it is taken for all the present and prospective purposes for which a public thoroughfare may properly be used, and the damages to the owner of the land are estimated with reference to such use; but the land can be used for no other purpose, and when the servitude ceases the land reverts to him free

from incumbrance. During the continuance of the servitude he is entitled to use the land, subject to the easement, for any and all purposes not incompatible with the public enjoyment. If the legislature authorizes the addition of any new servitude, essentially distinct from the ordinary use of a highway, like an elevated railroad, then the landowner is entitled to additional compensation; for it cannot be deemed, in law, to have been within the contemplation of the parties, at the time of the laying out of the road, that it might be used for such new and additional purposes. It has been held in New York, Illinois, and some of the United States circuit courts, that the use of a highway for a telegraph line will entitle such owner to additional compensation; but in the recent case of Pierce *v.* Drew (136 Mass. 75), the majority of our supreme court decided, that the erection of a telegraph line is not a new servitude, for which the landowner is entitled to additional compensation.

A minority of the court, in an able argument, maintained that the erection of telegraph and telephone posts and wires along the roads, fitted with cross-beams adapted for layer after layer of almost countless wires, which necessitate, to some extent, the destruction of trees along the highways or streets, the occupation of the ground, the filling of the air, the interference with access to or escape from buildings, the increased difficulty of putting out fires, the obstruction of the view, the presentation of unsightly objects to the eye, and the creation of unpleasant noises in the wind, is an actual injury to abutting land along the line, and constitutes a new and increased servitude, for which the landowner is entitled to a distinct compensation. After the rendering of the majority decision, the legislature very promptly passed a law allowing an owner of land abutting upon a highway, along which telegraph or telephone, electric light, or electric power lines shall be constructed, to recover damages to the full extent of the injuries to his property, provided he applies, within three months after such construction, to the mayor and aldermen or selectmen to assess and appraise his damage. (Stat. 1884, chap. 306.)

The public has a right to occupy the highway for travel and other legitimate purposes, and to use the soil, the grow-

ing timber, and other materials found within the space of the road, in a reasonable manner, for the purpose of making and repairing the road and the bridges thereon. (15 Johns, 447.) But the public cannot go upon the land of an adjoining owner without his consent, to remove stones or earth, to repair a bridge or the highway; and if in consequence of such removal the land is injured, by floods or otherwise, he can recover damages therefor. (107 Mass. 414.) He is not obliged to build or maintain a road fence, except to keep his own animals at home, but if he does build a fence he must set it entirely on his own land; and likewise, if a town constructs an embankment to support a road or bridge, it must keep entirely within the limits of the highway, for if any part of the embankment is built on his land, he can collect damages of the town. (4 Gray, 215; 136 Mass. 10.) He may carry water-pipes underground through the highway, or turn a watercourse across the same below the surface, provided he does not deprive the public of their rights in the way. (6 Mass. 454.) From the time of Edward IV, it has been the settled law that the owner of the soil in the highway is entitled to all the profits of the freehold, the grass and trees upon it and the mines under it. He can lawfully claim all the products of the soil and all the fruit and nuts upon the trees. He may maintain trespass for any injury to the soil or to the growing trees thereon, which is not incidental to the ordinary and legitimate uses of the road by the public. His land in the highway may be recovered in ejectment just the same as any of his other land. No one has any more right to graze his highway land than his tillage land. (16 Mass. 33; 8 Allen, 473.) He may cut the hay on the roadside, gather the fruit and crops thereon, and graze his own animals there, and the by-laws of the cities and towns preventing the pasturing of cattle and other animals in the highway are not to affect his right to the use of land within the limits of the road adjoining his own premises. (Pub. Stat., chap. 53, sect. 10.)

It is not one of the legitimate uses of the highway for a traveller or a loafer to stop in front of your house to abuse you with blackguardism, or to play a tune or sing a song

which is objectionable to you; and if you request him to pass on and he refuses to go, you may treat him as a trespasser and make him pay damages and costs, if he is financially responsible. (38 Me. 195.) And likewise, if any person does anything on the highway in front of your premises to disturb the peace, to draw a crowd together, or to obstruct the way, he is answerable in damages to you and liable to an indictment by the grand jury. (24 Pick. 187.)

Although the owner of the fee in a highway has many rights in the way not common to the public, yet he must exercise those rights with due regard to the public safety and convenience. Perhaps, in the absence of objections on the part of the highway surveyor, or of prohibitory by-laws on the part of the town, he has a right to take soil or other material from the roadside for his own private use, but he certainly has no right to injure the road by his excavations, or to endanger the lives of travellers by leaving unsafe pits in the wayside. He can load and unload his vehicles in the highway, in connection with his business on the adjoining land, but it must be done in such a manner as not unreasonably to interfere, or incommode the travelling public. When a man finds it necessary to crowd his teams and wagons into the street, and thereby blockade the highway for hours at a time, he ought either to enlarge his premises or remove his business to some more convenient spot. He has a right to occupy the roadside with his vehicles, loaded or unloaded, to a reasonable extent; but when he fills up the road with logs and wood, tubs and barrels, wagons and sleighs, pig-pens and agricultural machinery, or deposits therein stones and rubbish, he is not using the highway properly, but is abusing it shamefully, and is responsible in damages to any one who is injured in person or property through his negligence, and, moreover, is liable to indictment for illegally obstructing the roadway. (1 Cush. 443; 13 Met. 115; 107 Mass. 264; 14 Gray, 75; Pub. Stat., chap. 112, sect. 17.) As before said, he has a perfect right to pasture the roadside with his animals; but if he turns them loose in the road, and they there injure the person or property of any one legally travelling therein, he is answerable in damages to the full extent of the injuries, whether

he knows they have any vicious habits or not. (4 Allen 444.) If his cow, bull or horse, thus loose in the highway, gore or kick the horse of some traveller, he is liable for all damages (10 Cox, 102); and, in one instance, a peacable and well-behaved hog, in the road, cost her owner a large sum of money, because the horse of a traveller, being frightened at her looks, ran away, smashed his carriage and threw him out. (25 Me. 538.)

As an offset to his advantages as adjoining owner there are a few disadvantages. Highways are set apart, among other things, that cattle and sheep may be driven thereon; and as, from the nature of such animals, it is impossible, even with care, to keep them upon the highways, unless the adjoining land is properly fenced, it follows, that when they are driven along the road with due care, and then escape upon adjoining land and do damage, their owner is not liable therefor, if he makes reasonable efforts to remove them as speedily as possible. (114 Mass. 466.) Likewise, if a traveller, bent upon some errand of mercy or business, finds the highway impassable by reason of some washout, snowdrift, or other defect, he may go round upon adjoining land, without liability, so far as necessary to bring him to the road again, beyond the defect. (7 Cush. 408.) If a water-course on adjoining land is allowed by the landowner to become so obstructed by ice and snow, or other cause, that the water is set back, and overflows or obstructs the road, the highway surveyor may, without liability, enter upon adjoining land and remove the nuisance, if he acts with due regard to the safety and protection of the land from needless injury. (131 Mass. 522.)

A town or city has a right, in repairing a highway, to so raise the grade or so construct the water-bars within its limits, as to cause surface water to flow in large quantities upon adjoining land, to the injury of the owner thereof; but, on the other hand, the landowner has a right to cause, if he can, the surface water on his land to flow off upon the highway, and he may lawfully do anything he can, on his own land, to prevent surface water from coming thereon from the highway; and may even stop up the mouth of a culvert built by a town across the way for the purpose of conducting

such surface water upon his land, providing he can do it without exceeding the limits of his own land. (13 Allen, 211, 291; 136 Mass. 119.)

When the owner of land is constructing or repairing a building adjoining the highway, it is his duty to provide sufficient safeguards to warn and protect passing travellers against any danger arising therefrom; and if he neglects to do so, and a traveller is injured by a falling brick, stick of timber, or otherwise, he is responsible. (123 Mass. 26.)

If the adjoining owner of a building suffers snow and ice to accumulate on the roof, and allows it to remain there for an unusual and unreasonable time, he is liable, if it slides off and injures a passing traveller. (101 Mass. 251; 106 Mass. 194.) And, generally, the adjoining owner is bound to use ordinary care in maintaining his own premises in such a condition that persons lawfully using the highway may do so with safety.

The general doctrine as to the use of property is here as elsewhere, "*Sic utere tuo ut alienum non laedas*"; so use your own property as not to injure the rights of another. If you make an excavation on your land so near to a highway that travellers are liable to accidentally fall therein, you had better surround it with a fence or other safeguard sufficient to protect reasonably the safety of travellers. If you have any passageways, vaults, coal-holes, flap-doors, or traps of any kind on your premises, which are dangerous for children or unwary adults, you had better abolish them, or at any rate take reasonable precaution to cover or guard them in such manner as ordinary prudence dictates, and especially if they are near the highway; for if you don't, you may, some time when not convenient for you, be called upon to pay a large claim for damages or to defend yourself against an indictment. But if you have so covered and guarded them, and by the act of a trespasser, or in some other way without fault on your part, the cover, fence or guard is removed, you are not liable until you have had actual or constructive notice of the fact and have had reasonable opportunity to put it right. (4 Carr & P. 262, 337; 51 N. Y. 229; 19 Com. 507.)

Private Ways.

A private way is the right of passage over another man's land. And it may be established and discontinued in the same manner as a public way, and it may also arise from necessity. A way of necessity is where a person sells land to another which is wholly surrounded by his own land, or which cannot be reached from the public highways or from the land of the purchaser. In such case the purchaser is unable to reach his land at all, unless he can go over some of the surrounding estates; and inasmuch as he cannot go over the premises of those who are strangers to him, in law, and inasmuch as public policy and simple justice call for a passageway to his land, for his use in the care and cultivation of it, the law gives him a way of necessity over his grantor's land, which runs with his land, as appurtenant thereto, so long as the necessity exists, even if nothing is said in the deed about a right of way, because it is presumed that when the grantor sells the land he intends to convey with it a right of way, without which it could not be used and enjoyed; but when the necessity ceases the right ceases also. (14 Mass. 49; 2 Met. 457; 14 Gray, 126.) In the absence of contract, it belongs to the owner of a private way to keep it in repair (12 Mass. 65), and for this purpose he may enter upon the way and do whatever is necessary to make it safe and convenient; but if in so doing he removes soil and stones which are not needed on the way, such surplus material belongs to the owner of the land over which the way passes. (10 Gray, 65.) If a defined and designated way becomes impassable for want of repair or by natural causes, the owner of the way has not the right of a traveller on a public road to go outside the limits of the way in order to pass from one point to another. (Wash. on Ease. 196.) But if the owner of the land obstructs the way, a person entitled to use it may, without liability, enter upon and go over adjoining land of the same owner, provided he does no unnecessary damage. (2 Allen, 543.) The reason for this distinction in the law between a public and private way, is that in the case of a private way, the owner of the way, who alone has the right to its use, is bound to

keep it in repair, whereas in the case of a public way the traveller is under no obligation to keep it in passable condition. A private way once established cannot be relocated except with the consent of both the owner of the land and of the way; but if both are agreed, the old way may be discontinued and relocated in another place. (5 Gray, 409; 14 Gray, 473). The owner of the soil of a private way may, the same as the owner of the fee in a highway, make any and all uses thereof to which the land can be applied. (Wash. on Ease. 196.) In the absence of agreement to the contrary, he may lawfully, and without liability, cover such way with a building or other structure, if he leaves a space so wide, high and light, that the way is substantially as convenient as before for the purpose for which it was established. (2 Met. 457.) And so, in the absence of agreement, he may maintain such fences across the way as are necessary to enable him to use his land for agricultural purposes, but he must provide suitable bars or gates for the use and convenience of the owner of the way. He is not required to leave it as an open way, nor to provide swing gates, if a reasonably convenient mode of passage is furnished, and if the owner of the way or his agents leave the bars or gates open, and in consequence thereof damage is done by animals, he is liable to respond in damages. (31 N. Y. 366; 44 N. H. 539; 4 M. & W. 245.) The law of the road applies as well to private as to public ways, as the object of the law is to prescribe a rule of conduct for the convenience and safety of those who may have occasion to travel, and actually travel, with carriages on a place adapted to and fitted, and actually used, for that purpose. (23 Pick. 201.) The description of a way as a "bridle-road" does not confine the right of way to a particular class of animals or special mode of use, but it may be used for any of the ordinary purposes of a private road. (16 Gray, 175.)

Don't.

In school, church and society, many things are taught by the prohibitory *don't*, and so many rules of law relating to public and private ways may be taught and illustrated in the same way. For instance: —

Don't ever drink intoxicating liquors as a beverage, at least in large quantities. If you ever have occasion to use it at all, use it very sparingly, especially if you are travelling, or are about to travel, with a team; for, if you should collide with another team, or meet with an accident on account of a defect in the way, in a state of intoxication, your boozy condition would be some evidence that you were negligent. The law, however, is merciful and just, and if you could satisfy the court or jury that, notwithstanding your unmanly condition, you were using due care, and that the calamity had happened through no fault of yours, you would still be entitled to a decision in your favor; but when you consider how apt a sober human mind is to think that an intoxicated mind is incapable of clear thought and intelligent action, I think you will agree with the decisions of the courts, which mean, when expressed in plain language, "You had better not be drunk when you get into trouble on the highway." (3 Allen, 402; 115 Mass. 239.)

Don't ever approach a railway crossing without looking out for the engine while the bell rings, and listening to see if the train is coming; for there is good sense as well as good law in the suggestion of Chief Baron Pollock, that a railway track *per se* is a warning of danger to those about to go upon it, and cautions them to see if a train is coming. And our court has decided that when one approaches a railway crossing he is bound to keep his eyes open, and to look up and down the rails before going upon them, without waiting for the engineer to ring the bell or to blow the whistle. (12 Met. 415.) It is a duty dictated by common sense and prudence, for one approaching a railway crossing to do so carefully and cautiously, both for his own sake and the sake of those travelling by rail. If one blindly and wilfully goes upon a railway track, when danger is imminent and obvious, and sustains damage, he must bear the consequences of his own rashness and folly.

Don't drive horses or other animals affected by contagious diseases on the public way, or allow them to drink at public watering places, or keep them at home, for that matter. The common law allows a man to keep on his own premises horses afflicted with glanders, or sheep afflicted with foot-

rot, or other domestic animals afflicted with any kind of diseases, provided he guards them with diligence and does not permit them to escape on to his neighbor's land or the public way. But, under the statute law of this State, a man having knowledge of the existence of a contagious disease among any species of domestic animals, is liable to a fine of five hundred dollars, or imprisonment for one year, if he does not forthwith inform the public authorities of such disease. (Stat. 1885, chap. 148.) Aside from the penalty of the statute law, it is clearly an indictable offence for any one to take domestic animals affected with contagious diseases, knowing, or having reason to know, them to be so affected, upon the public ways, where they are likely to give such diseases to sound animals; and he would be answerable in damages besides. (2 Rob., N. Y. 326; 16 Conn. 200.)

If you are afflicted with a contagious or infectious disease, *don't* expose yourself on a highway or in a public place; and don't expose another person afflicted with such disease, as thereby you may jeopardize the health of other people, and your property also, in case you should be sued by some one suffering on account of your negligence. (4 M. and S. 73; Wood on Nuisances, 70.)

When there is snow on the ground and the movement of your sleigh is comparatively noiseless, don't drive on a public way without having at least three bells attached to some part of your harness, as that is the statute as well as the common law. By the statute law you would be liable to pay a fine of fifty dollars for each offence. And by the statute and common law, in case of a collision with another team, you would probably be held guilty of culpable negligence and made to pay heavy damages. Of course you would be allowed to show that the absence of bells on your team did not cause the accident, or justify the negligence of the driver of the other team, but it would be a circumstance which would tell against you at every stage of the case. (12 Met. 415; 11 Gray, 342; 8 Allen, 436.)

If you have no acquaintance with the nature and habits of horses and no experience in driving or riding them, *don't* try to ride or drive any of them on a public way at first, but

confine your exercise in horsemanship to your own land until you have acquired ordinary skill in their management, for the law requires every driver or rider on a highway to be reasonably proficient in the care and management of any animal he assumes to conduct through a public thoroughfare. (2 Lev. 173.)

Don't ride with a careless driver, if you can help it, because every traveller in a conveyance is so far identified with the one who drives or directs it, that if any injury is sustained by him by collision with another vehicle or railway train, through the negligence or contributory negligence of the driver, he cannot recover damages for his injuries. The passenger, in law, is considered as being in the same position as the driver of the conveyance, and is a partaker with him in his negligence, if not in his sins. (1 Addison on Torts, sect. 479.)

If you have a vicious and runaway horse, and you know it, you had better sell him, or keep him at work on the farm. *Don't*, at any rate, use him on the road yourself, or let him to other people to use thereon, for if in your hands he should commit injuries to person or property, you would have to foot the bills; and if he should injure the person to whom you had let him, unless you had previously informed him of the character and habits of the horse, you would be liable to pay all the damages caused by the viciousness of the horse. If you should meet with an accident by reason of a defect in the highway, you could not recover anything, however severely you might be injured or damaged, provided the vicious habits of the horse contributed to the accident. (4 Gray, 478; 117 Mass. 204.)

In riding or driving keep hold of the reins, and *don't* let your horses get beyond your control; for if you do, your chances of victory in a lawsuit will be pretty slim. If you tie up your reins for the purpose of walking in order to get warm or to lighten the load, and let your horses go uncontrolled, and they run over a child in the road and kill it, or seriously injure it, you will probably have to pay more than the value of the horses, unless they are very good ones. Or if going thus uncontrolled they fail to use due care and good judgment in meeting othei teams, and in consequence

thereof damages occur, you would be expected to make everything satisfactory, because your team is required to observe the law of the road whether you are with it or not, especially if you turn it loose in the highway. Even if you have hold of the reins, and your horses get beyond your control by reason of fright or other cause, and afterwards you meet with an accident by reason of a defect in the highway, you cannot recover anything. (101 Mass. 93; 106 Mass. 278; 40 Barb. 193.)

Don't encroach upon or abuse the highway, either by crowding fences or buildings upon its limits, or by using it as a storage yard. If you set a building on the line of the road, and then put the doorsteps, the eaves, and the bow-windows of the building over the line, you are liable to an indictment for maintaining a public nuisance; and possibly you may be ordered by the court to remove them forthwith at your own expense. (107 Mass. 234.) If you build an expensive bank-wall for a road fence, and place any part of it over the line, you must remove it upon the request of the public authorities, or else take your chances on an indictment for maintaining an illegal obstruction in the highway. If you deposit on the roadside logs, lumber, shingles, stones, or anything else which constitutes an obstruction to travel or a defect in the way, or which is calculated to frighten horses of ordinary gentleness, and allow the same to remain for an unreasonable length of time, you are liable to respond in damages for all injuries resulting therefrom. Even if the town should have to settle for the damages in the first instance, you might still be called upon to reimburse the town. (107 Mass. 234; 102 Mass. 341; 18 Me. 286; 41 Vt. 435; Wood on Nuisances, sects. 326, 327.)

Don't ride on the outside platform of a passenger coach, for if you cling upon a crowded stage-coach or street car, and voluntarily take a position in which your hold is necessarily precarious and uncertain, you have no right to complain of any accident that is the direct result of the danger to which you have seen fit to expose yourself. However, if the coach is stopped for you to get on and fare is taken for your ride, the fact that you are on the platform is not conclusive evi-

dence against you; but the court will allow the jury to determine, upon all the evidence and under all the circumstances, whether you were in the exercise of due care, instructing them that the burden of proof is upon you to show that the injury resulted solely by the negligence of the proprietors of the coach. (103 Mass. 391; 8 Allen, 234; 115 Mass. 239.)

Don't jump off a passenger coach when it is in motion; for if you get off without doing or saying anything, or if you ring the bell and then get off before the coach is stopped, without any notice to those in charge of it, and without their knowing, or being negligent in not knowing, what you are doing, the coach proprietors are not liable for any injury you may receive through a fall occasioned by the sudden starting of the coach during your attempt to get off. (106 Mass. 463.)

Don't wilfully break down, injure, remove or destroy, a milestone, mile-board or guide-post erected upon a public way, or wilfully deface or alter the inscription on any such stone or board, or extinguish a lamp, or break, destroy or remove a lamp, lamp-post, railing or posts erected on a street or other public place, for, if you do, you are liable to six months' imprisonment or a fine of fifty dollars. (Pub. Stat., chap. 203, sect. 76.)

If in travelling you find the road impassable, or closed for repairs, and you find it convenient to turn aside and enter upon adjoining land in order to go on your way, *don't* be careless or imprudent, for if you take down more fences and do more damage than necessary you may have to answer in damages to the owner of the land; and, if you meet with an accident while thus out of the road, you cannot look to the town for any remuneration therefor, because when you go out of the limits of the way voluntarily, you go at your peril and on your own responsibility. (8 Met. 391; 7 Cush. 408; 7 Barb. 309.)

Don't make the mistake of supposing that everything that frightens your horse or causes an accident, in the highway, is a defect for which the town is liable. If a town negligently suffers snowdrifts to remain in the road for a long time, and thereby you are prevented from passing over the road to

attend to your business, or, in making an attempt to pass, your horses get into the snow, and you are put to great trouble, expense and loss of time, in extricating them, you are remediless, unless you receive some physical injury in your person or property; as the remedy provided by the statutes, in case of defects in the highway, does not extend to expenses or loss of time unless they are incident to such physical injury. In other words, the statute gives no one a claim for damages sustained in consequence of inability to use a road. (13 Met. 297; 6 Cush. 141.) And so a town or city is not obliged to light the highways, and an omission to do so is not a defect in the way for which it is liable. (136 Mass. 419.)

Nor is the mere narrowness and crookedness of a road a defect within the meaning of the statutes. Towns and cities are only required to keep highways in suitable repair as they are located by the public authorities, and they have no right to go outside the limits defined by the location in order to make the road more safe and convenient for travel. If a highway is so narrow or crooked as to be unsafe, the proper remedy is by an application to the county commissioners to widen or straighten it. (105 Mass. 473.) Nor is smooth and slippery ice, in country road or city street, a defect for which a town or city is liable, if the road whereon the ice accumulates is reasonably level and well constructed. In our climate the formation of thin but slippery ice over the whole surface of the ground is frequently only the work of a few hours, and to require towns and cities to remove this immediately, or at all, is supposing that the legislature intended to cast upon them a duty impossible to perform, and a burden beyond their ability to carry. (12 Allen, 566; 102 Mass. 329; 104 Mass. 78.)

If you meet with an accident on the highway by reason of a defect therein, *don't* fail to give notice in writing within thirty days, to the county, town, place or persons, by law obliged to keep said highway in repair, stating the time, place and cause of the injury or damage. (Pub. Stat., chap. 52, sects. 19–21.) This notice is a condition precedent to the right to maintain an action for such injury or damage, and cannot be waived by the city or town. (128

Mass. 387.) Nothing will excuse such notice except the physical or mental incapacity of the person injured, in which case he may give the notice within ten days after such incapacity is removed, and in case of his death by his executors or administrators. (Pub. Stat., chap. 52, sect. 21.) Formerly it was essential that the time, place and cause of the injury should be set forth in the notice with considerable particularity, but now the notice is not invalid by reason of any inaccuracy in stating the time, place and cause, if the error is not intentional and the party entitled to notice is not misled. (Stat. 1882, chap. 36.)

Don't convey by warranty deed a piece of land over which there is a public or a private way, without conveying subject to such way; for if you do, you may be called upon to make up the difference in value in the land with the incumbrance upon it and with it off, which is regarded as a just compensation for the injury resulting from such an incumbrance. (2 Mass. 97; 15 Pick. 66; 2 Allen, 428.)

Finally, *don't* keep a dog that is in the habit of running into the road and barking at passing teams. You had better get rid of him or break him of the habit. Under our statutes the owner or keeper of a dog is responsible to any person injured by him either in person or property, double the amount of damage sustained; and after he has received notice of the bad disposition of his dog, he is liable to have the damage increased threefold.

Every dog that has the habit of barking at people on the highway is liable any day to subject his owner or keeper to large liabilities; for if he frightens a horse by leaping or barking at him in mere play, and the horse runs away, or tips over the vehicle to which he is hitched, his owner or keeper is responsible for double the damages thus caused by his dog. Hence I repeat the injunction, get rid of such a dog or break him of the habit, and if this cannot be done, then break his neck.

Perhaps it might be well to say, in this connection, that any traveller on the road, either riding or walking peaceably, who is suddenly assaulted by a dog, whether licensed or not, may legally kill him, and thus relieve his owner or keeper of a disagreeable duty. (11 Gray, 29; 1 Allen, 191; 3 Allen, 191.)

Mr. Ware. Suppose a person on foot is crossing the highway, and a carriage is driven so that if both should continue they would come in contact. Is it the duty of the driver to stop, or must the person on foot give way?

Mr. Potter. There is no law that meets that point. If there is a collision and complaint, it is a question of fact for the jury in each case, after hearing the evidence, to say which party was at fault. There is no law that says that one shall stop, or the other shall stop. The party who brought the suit would have to convince the jury, in order to maintain his case, that the injury resulted wholly from the negligence of the other party.

Mr. Ware. Suppose a wilful boy stands directly in the rut of the road, does the law of the road require the driver of a carriage to turn out for the boy, or may he run over his toes if he does not remove them?

Mr. Potter. I should say the same in regard to that as in the other case. You certainly would not have a right to drive over a person who planted himself in the middle of the road and insisted upon standing there. The person would be liable to punishment by indictment for obstructing the road, but it would certainly never do for any one, and the law would not justify it, to wilfully and purposely run over any person. He must seek redress in another way; he must not take the law into his own hands.

Mr. Ware. Even to fetching him a cut with the whip?

Mr. Potter. The evidence would have to go to the jury; and if you struck him with the whip, and the jury thought that was justifiable under the circumstances, very likely you would get your case.

Mr. Ware. Suppose three or four persons were passing along the highway on foot and a carriage came up behind them, ought those on foot to turn out, or must the carriage turn out?

Mr. Potter. I should say it would be the duty of the men on foot to clear the highway sufficiently for the team to go by. The same law would apply to them that applies to teams. If there are two teams travelling the same way on the highway, and the forward team, as I stated, refuses wilfully to let the other go by, the driver is liable for obstruct-

ing the highway and may be compelled to pay damages. If a man on foot did the same thing he would be liable in the same way.

Mr. WARE. Would the driver of the carriage in the rear be justifiable in letting his horse go so near the other as to enable him to bring his whip across his head?

Mr. POTTER. The driver of the first carriage ought to give the person behind at least half the travelled part of the road. If he insisted upon taking up all of the travelled part of the road, I think, if I was driving, I should drive very near to him.

Mr. WILCOX. Suppose a man is taking a journey for pleasure or profit on Sunday to a neighboring town, and there is a defect in the highway, and in consequence he receives damages, is injured personally, or his vehicle or horse is injured, can he recover damages of the town?

Mr. POTTER. Yes, he can, if the town is at fault in having the way unsafe. That was not so until two years ago, when the legislature passed a law by which it was provided that no person should be prevented from recovering damages, in case of an injury through a defect in the way, because he was travelling on Sunday.

Mr. WILCOX In the State of Maine the law was such, a few years ago, that a man travelling on Sunday could not recover damages from a town for any injuries received in consequence of a defect in the highway.

Mr. POTTER. That has been the law here until recently.

Mr. EDSON. I understood you to say that a road which has been left open to the public for twenty years becomes a public highway. Is the town obliged to keep that highway in repair?

Mr. POTTER. Unless it has been accepted by the public, by doing something like repairing it or taking charge of it, it would not be a public road, for which the town would be liable, at all; it would be merely a private way. But if the town had been on and repaired it, taken control of it, the town would be liable for any accident that might happen by reason of any defect in the way.

Mr. EDSON. I have a case in mind of that very kind, where there was a way leading through the woods which had

never been accepted by the town. The surveyors of the town, supposing it to be a town way, did some repairs on it. Did that make it forever after a town way, subjecting them to keep it in repair?

Mr. POTTER. That would be a question that would have to be submitted to the jury, under proper instructions from the court. I had a case like that, two years ago this winter, where evidence was put in as to what the town had done, and the result turned on the question whether the town had ever passed any vote relative to it; whether they had ever made any repairs upon it. If the jury think that in making such repairs the town has exercised such authority over it that it ought to be a public way, they would be warranted in finding a verdict against the town. On the other hand, if the town had never exercised any control over it, never had made any repairs, I suppose if a surveyor goes on, of his own motion and without any instruction from the town, that will not make the town liable.

Mr. EDSON. I understood you to say that a town has authority to lay out a road in certain cases, and in certain other cases it required action by the County Commissioners. What is the difference? Why cannot a town go on and lay out any road?

Mr. POTTER. I have dealt with that question in my lecture; but thinking it was too long, I left that part out in my reading. The selectmen of a town can only lay out roads where both termini are within the limits of the town; that is, they cannot go across the line. If you want a road within the limits of your town, you can petition the selectmen to lay it out; and the selectmen, if they think the public safety and convenience require it, go on and make a plan of the proposed road, which they submit to the town meeting, and if the town meeting authorizes the building of the road, then it is built, and the County Commissioners have nothing to do with it; that is a town way. But if you want a road stretching from one town to another, or to several towns, then the selectmen have no authority; you must go to the County Commissioners, who have authority to lay out highways from one town to another.

Mr. EDSON. Suppose we take this case: that the town

will not lay out a road, the whole of which is in the town, but connected with another road, a county road; in that case, who would have authority?

Mr. Potter. You can always go to the County Commissioners in such a case, even if it is in your own town. You can either go to the County Commissioners or go to the town, whichever way is thought most agreeable and convenient to the parties.

Mr. Edson. There is another case you have not spoken of in your lecture. In case we wish to cross a railroad, do we have to go not only to the County Commissioners, but to the Railroad Commissioners?

Mr. Potter. Yes.

Mr. ——. You spoke of removing dirt from the highway. Has a person the right to take the soil in front of his own premises and appropriate it to his own use, if he does not injure the highway?

Mr. Potter. I am inclined to think that he would, although I put that in my lecture very guardedly. I said perhaps a person might remove dirt, if the highway surveyor or the town by-laws did not prohibit him from doing it. I notice that Judge Bennett, in his "Law of the Road," states that a person has a right to take the dirt in front of his own land, if he does not take enough to injure the public travel. I am not quite certain that the law would justify that.

Mr. Edson. Suppose the road surveyor wants it, has he a right to take it?

Mr. Potter. He has a right to take it from one part of the town to another. I suppose a town would have the right to pass a by-law saying that nobody should have a right to do it. If the town did not pass such a law, and the highway surveyors did not notify the owner of the abutting estate that they wanted it, probably the owner would have a right to take such part of it as would not be detrimental to the public need. But I am inclined to think there is a good deal to be said on the other side of that. I have left it in rather an indefinite way.

Mr. Edson. Suppose that the County Commissioners lay out a road, and the town has to fill across a valley in order

to build it, and the County Commissioners require us to make the road a certain width, must we build a stone wall just exactly on the line?

Mr. Potter. You have no right to go beyond the line an inch.

Mr. Edson. In case we cut through a hill, and find that the bank stands at an angle of forty-five degrees, must we bank up the sides of that road with a bank wall, or may we make it wider?

Mr. Potter. I should think you would have to lay the bank wall, or go to the Commissioners and get them to lay out the road wider. I should think, in such a case, when the County Commissioners saw that the hill was left in a bad condition, they would lay out the road wider.

Mr. Edson. You say that trees belong to the owner of the property who sets them in front of his buildings. I know that the surveyors have a right to lop off limbs, if they interfere with public travel; but suppose the tree blows down, who is responsible for removing it, the town or the owner?

Mr. Potter. I think the owner would have a right to remove it, and use it for firewood or for timber.

Mr. Edson. Suppose he does not choose to remove it?

Mr. Potter. Then, if it is an obstruction, it is the duty of the town to remove it.

Mr. Edson. He cannot be compelled to remove it?

Mr. Potter. No, sir; but if he neglects it, he forfeits it to the use of the town.

Mr. Stratton. Suppose a man has a road through his farm that he is obliged to use, can the public gain possession of that road?

Mr. Potter. It would become a prescriptive way by using it twenty years.

Secretary Russell. I want to have Mr. Potter add something to his answer to Mr. Edson in regard to town ways. Where a petition is before the selectmen and they refuse to act upon it, and conclude that it is not necessary, — they being opposed to it, perhaps, from personal reasons, — may I take it before the town meeting and compel them to act upon it?

Mr. POTTER. No; you cannot compel them. There the only remedy is to appeal to the County Commissioners.

Secretary RUSSELL. Where there is a refusal to act, or the town does not choose to act, then may I still have an appeal to the County Commissioners?

Mr. POTTER Yes, sir. If the selectmen refuse to act, you can appeal to the County Commissioners; or, if the selectmen are in favor of the project and the town refuses to act, you can go to the County Commissioners.

Mr. EDSON. I understand it in this way, that if you can get ten signers to a petition, you can compel the selectmen to put it in the warrant.

Mr. POTTER. Yes.

Mr. EDSON. That will bring it before the town without any trouble. No matter how much the selectmen may be opposed to it, if you can get ten signers to a request to the selectmen, it must appear in the warrant and go before the town meeting.

Mr. POTTER. Yes; in that case.

(Mr. WARE in the chair.)

ARTIFICIAL REARING OF POULTRY.

BY JAMES RANKIN, OF SOUTH EASTON.

Mr. President and Gentlemen of the Board, and Brother Farmers:

I feel glad to meet you here to-day; the more so, as I know the interest which I represent is of the most vital importance to every New England farmer. We are all more or less acquainted with the great dairying interests of the country and the relative profits derived therefrom; of the vast quantities of beef and pork product; of the enormous crops of cotton, wheat and corn; of the immense capital involved in the manufacturing departments of the country. But few of us have ever dreamed (until within a year or two) that the poultry interest of the country in magnitude exceeds either of the above productions. The poultry business has always had wonderful attractions for me. From the gathering of the eggs and the caring for a few broods of chicks during early boyhood, to hatching and rearing fowls artificially by the thousands in maturer years, it has always

been a source of pleasure as well as profit. I can truly say that the fever has never abated with me. Failure only made me more anxious to try again, being careful never to repeat the same mistake. During the last fifteen years, the artificial process has been particularly fascinating to me: watching the rapid development of the germ in the egg, the gradual increase of circulation and heat in the embryo chick, until it bursts the shell, — a perfect thing. I propose to give you a detailed account of my sixteen years' experience in artificial poultry growing, with the relative profits derived, as compared with the natural method. I have found it one thing, however, to grow poultry successfully and profitably on one's own premises at home, but quite another to intelligently represent it, so that others can go and do likewise.

The first twenty years of my poultry experience was confined to the natural method, using hens alone. The next ten years hens and incubators were used, side by side, in the same building. The first part of that decade the hens were victorious, — biddy coming out ahead every time; the latter part of the time mentioned, the machines took the lead and kept it. For the past six years machines have been used exclusively, the hens being kept entirely for egg production.

My own experience has taught me that in growing poultry artificially, a yearly profit of one hundred per cent. can be easily made on all capital invested in the shape of buildings, machinery, stock, etc.

My first Experience with Incubators.

The Old Way. — Setting Hens. — Tending the Machine. — Disastrous Results.

In the year 1868 quite an excitement was created in poultry circles, in the vicinity of Boston, by the introduction of an incubator, the manufacturer of which claimed that it not only hatched as well or better than hens, but that it regulated its own heat, required little or no care and attention, and could be easily operated without in any way interfering with one's regular business.

Now this was just what I had been looking for. I had been engaged in growing poultry from boyhood, and at the

time spoken of had gotten the fever badly. For some ten years previous I had been in the habit of getting out from twelve to fifteen hundred chicks and ducks, during the spring months of each year, by the old hen process, and it had not always proved satisfactory. For, though I could always find a ready market for early spring chicks, at from sixty to seventy-five cents per pound, at the club-houses and first-class hotels in Boston, I could not always induce biddy to commence business in time to furnish them. She was carefully fed; fancy nests were fixed up in the nooks and corners, and filled with porcelain eggs; in fact, every facility was afforded her, as an inducement to begin, but with only partial success.

Then, again, during the months of May and June, when we wished to retire from business, the nests were invariably filled with persistent sitters. There was a constant battle, with water-barrels, red rags, solitary confinement on the one side, and persistent obstinacy on the other. I did not then know that the introduction of a vigorous young cock among a yard of sitters, with plenty of food and exercise, was far more effective in inducing a change of mind than more vigorous treatment, cold baths and signals included.

This machine was going to relieve me from all further trouble, and hatch out the chicks just when they were the most valuable. I visited Boston and saw the machines in operation. The eggs were taken out and broken at different stages of development. Everything appeared to be satisfactory; a five-hundred-egg machine was purchased, taken home and set up, and in due time filled with eggs, precaution being taken to set fifteen or twenty hens at the same time. These hens were intended to accommodate the machine chicks in addition to their own. The machine was a very expensive one, and it had, at least, two good qualities: It was most thoroughly built in every part, and could generate all the heat needed to incubate eggs in a temperature below freezing point.

I soon found, however, that the difficulty did not consist so much in generating the heat as in controlling it. The regulating apparatus consisted of a glass syphon, some two feet long, filled partly with alcohol and partly with mercury;

the alcohol being inside of the machine and the mercury outside. In this mercury was inserted a wired cork. The heat was expected to expand the alcohol, force up the mercury, and raise the cork. Now, as this cork was attached by a small wire to the ventilator, and by a second wire to a cut-off on the lamp, and worked simultaneously on both, the least expansion or contraction of the alcohol by heat or cold was expected to control the heat in the egg-chamber. But as, unfortunately, the alcohol was placed in the extreme bottom of the machine, where there was the least heat, and the eggs in the top, where there was the most heat, so that, as the heat increased, the eggs got the benefit of it first and the liquor afterwards, the damage was done before the remedy was provided.

I wrote to the manufacturer, stating the difficulty. He assured me that the machine was all right, and that the trouble was in me and entirely the result of my own ignorance and inexperience, and that I would soon get the hang of it. This was not consoling, but I resolved that if there was any virtue in persistency I would succeed.

I will here digress enough to say that a course of twelve years with that machine did not give me experience enough to run it without the regular nightly visitations. The thing sat like an incubus on my shoulders, and during the four months of each year I never knew the luxury of sleeping a single night without being obliged to get up, dress, and wend my way to that incubator room, often in storms or wallowing through snowbanks, sometimes with the mercury below zero. But I did not flinch. I resolved that if failure it was, it would not be through me.

During this time the twenty hens were properly cared for. My habit was to take off the birds, during the extreme cold weather, in the warmest part of the day; and during the fifteen minutes they were off, feeding and dusting, the eggs were carefully covered with a circular piece of paper, so that, when the birds returned to the nests, the eggs had cooled but a few degrees. At the end of twenty days there was a great chipping and chirping under the hens, and at the close of the twenty-first day more than two hundred lively Brahma chicks had made their appearance; but there

were no signs of life in the machine. I felt much discouraged about this, because experience had often taught me that when chicks came out forty-eight hours behind time their number was sure to be small and their life short. During the twenty-second day a faint chirping was heard, and a few eggs pipped. At the close of the twenty-third day about thirty chicks, with my assistance, made their appearance; without that, they never would have seen the light of day. They were a sorry-looking set at best. The down was plastered to their bodies by a sort of mucilaginous secretion from the eggs. They seemed lifeless and debilitated, and when consigned to the old hen, kept her in a constant fever with their sickly plaints. They refused to eat; dropped off, one by one, and were soon a thing of the past. All this time their natural and more favored brothers were doing first-class work, as far as consumption of food and growth were concerned.

Well, my first attempt at artificial incubation had found a disastrous failure. Biddy had come out a long way ahead; and to add to my trouble, my neighbors, who had looked on incredulously from the first, now began to console me with the old refrain: "What did I tell you?"

By the way, I advise every one who intends purchasing an incubator to keep it a profound secret from his neighbors. Call the thing a "cold-blast refrigerator," or anything you please, but keep the neighbors out of the way until you have a good hatch, then invite them in to see the chicks come out. If you happen to have a poor hatch, and they should find it out, as they always will, you will feel like whipping somebody.

My courage, though somewhat abated, had not all oozed out. I was resolved to try again, yet I did not see how I could improve upon what I had done; I could get neither advice or consolation from the inventor. The instructions were few and simple, and I had followed them to the letter. "Trim your lamps once and turn your eggs twice a day. Run your machine at 103°. Change your trays twice each day, putting your lower ones above and your upper ones below each time. Be sure and cool your eggs off fifteen minutes each day, taking them out of the machine to do it. Keep your evaporating pans full of water."

My machine was again filled with eggs, twenty-five dozen more were consigned to the care of brooding hens at the same time, and the same routine carried out as before, though the details were, if possible, more carefully observed than ever. In the meantime the business was conducted in the natural way the same as of yore. Whenever a hen became broody she was supplied with eggs, and I had forty or fifty sitters constantly at work. In due time the hens that were set with the machine duplicated their former hatch. The machine did the same and came out as far behind as ever.

That machine was filled a third and fourth time with no better success. A fifth time it was filled with ducks' eggs, out of which I did not get a single duck, except two or three which I picked out, and those died at once; while my hens that behaved themselves, got out an average of eleven ducks out of every twelve eggs intrusted to their care.

It thus was an open question in my mind whether artificial incubation under the most favorable circumstances could be made a success. I had put nearly two hundred dozen eggs through that machine. Those eggs were worth the greater part of the time fifty cents per dozen. (That was the price I obtained for them the entire winter from private families in Boston, they paying the express.)

Out of that two hundred dozen eggs I had got out less than two hundred sorry-looking chicks. Those chicks had come out apparently in all stages of development, and in every conceivable deformity. There were crooked legs, twisted bills, humpbacks, clump feet. Numbers came out with the digestive organs attached on behind, like the antennæ of a wasp, outside of the chick instead of inside, where they ought to be. One in particular introduced himself with one leg below and the other on his back above, both so attached that he could make use of neither. Those machine chicks, unlike their natural brothers, had a strong antipathy to locomotion; activity was their aversion. Their general aspect was that of profound meditation. Their favorite attitude was reclining on their broadside. They were bound to shuffle off this mortal coil at all hazards, and no amount of petting or coaxing could induce them to reconsider their decision.

I have my doubts to-day if I succeeded in maturing a single one of these machine chicks. There could be no fault with the eggs, or the fowls from whence they came. In an experience of thirty years, I have never had so highly fertilized eggs during the winter months as during these trials; fully ninety-eight per cent. were fertile. Hens that behaved themselves came out with broods of from ten to twelve chicks, and sometimes hatched every egg. On May 1, in summing up the winter's work, the account was thus: From one hundred and eighty dozen eggs consigned to hens, nearly one thousand chicks and two hundred and eighty ducklings. From two hundred dozen put through the incubator, 0.

During this time I had done some thinking. There was plainly a cause or causes for these failures. It was for my interest to discover and remove them, or else throw aside the machine as worthless, which I was not yet prepared to do. It had cost too much money for that.

There was one thing that was entirely amiss. The machine chicks had invariably come out behind time, and yet I had repeatedly put glasses under hens to ascertain the temperature, which I found about 103°, and then run the machine the same. But I found that when the five hundred eggs were taken out of the incubator and cooled off in a cold room for fifteen minutes, that when they were returned to the machine there was such a large body of them that the eggs seemed to cool the air in the machine instead of the air warming the eggs; so much so, that when the room was cold, it was often three and even four hours before the eggs reached their normal heat. Thus in reality I had been running at a temperature of from 75° to 103°.

How had biddy been running? I would find out about that. A hen was taken off the nest for fifteen minutes and then returned; when finally settled down, a glass was carefully placed under her. In twenty minutes those eggs, brought into immediate contact with the rapidly pulsating arteries of the hen's body, were back to their normal heat of 103°. Here was the solution of the difficulty, and yet my instructions were imperative to cool the eggs fifteen minutes each day. But I found that cooling the eggs fifteen minutes

with the room at a temperature of 40° did as much execution as cooling them fifty minutes with the room at a temperature of 80°. Evidently things were mixed at headquarters.

It now occurred to me that though cooling off the eggs might be a necessity to the old hen, it might not be at all essential to the welfare of the embryo chick. Nothing easier than to find out. I would run an experimental machine for the purpose and settle the thing once for all.

I procured three paper box covers, perforated the bottom with holes, and placed them in the machine, in the centre of the drawers, with a dozen eggs in each.

One box of these eggs was taken out daily and cooled to the usual temperature. Another was taken out and cooled while trimming the lamp, about three minutes. The other box was not taken out during the batch, the eggs being turned in the machine. The result of that experiment was six chicks from the box of cooled eggs, and dead chicks in the other six eggs in all stages of development.

The box taken out for a moment or two hatched ten chicks, and two died in the shell. From the box that was not moved I took eleven lively chicks, the remaining egg being unfertile. Those eleven chicks came out with that fine yellow tinge which characterizes your healthy Brahma chick hatched in the natural way.

To say that I felt relieved does not express it. I was jubilant. I even went so far as to tell some of my loquacious neighbors that they would see a thing or two when the next season opened.

I made arrangements for an early start the coming winter, as what broilers I had sold had brought sixty-five cents per pound at the club-houses in Boston and I did not have enough to supply the demand. I started machines and hens about the first of January, taking every precaution to ensure success. My chagrin may be imagined, when, as I had confidently expected at least ninety per cent. to hatch, I in reality got but forty per cent. The rest of the eggs contained chicks dead in all stages.

It is true that it was a decided improvement on the last winter; I had three times as many chicks, and they were all doing well. They had also been hatched on time, which

was a great point. I tried a second hatch with the same result, biddy coming out as usual.

I had no longer doubts about the success of artificial incubation. Those eleven chicks, the previous year, had proved it beyond a doubt. Notwithstanding the inventor's assertion, I believed the trouble was in the machine, and not in me; because I had heard, in a roundabout way, that he was not doing any better than I was, — in fact, not as well, — and I found that a great many others were victimized with it like myself.

In an unfortunate moment, just after I was through with that experimental hatch, the season before, the inventor had written me for a testimonial, and, being elated at the time, I wrote him that I had just got a one hundred per cent. hatch.

Of course he made free use of it, and it materially assisted him in victimizing others.

Being throughly convinced that the machine was at fault and not myself, I overhauled it in every part. I found that the egg-chamber was heated by perpendicular tanks on all sides except that occupied by the door in front; also by a tank over the top.

The machine was ventilated through the tank over the top, in the centre of the egg-chamber, the cold air being admitted through the doors in front. By this arrangement, at the back of the egg-chamber, where it was all tank, and constant heat radiating therefrom, there was no ventilation, while in front, where there was no heat, was located all the ventilation.

It was easy to see now where the trouble was. But why had I not seen this before? I had blindly thrown away hundreds of dollars' worth of time and eggs during the first two years. I wrote the inventor, plainly stating the defects in the construction of his machine, and asked him if he would not remodel it to suit me. He answered me by asking if I pretended to know more about the machine than the manufacturer who invented it.

I purchased a dozen glasses at once, resolved to know the extent of the trouble. I placed these glasses in every part of the egg-chamber. I found that while the temperature

was 103° in the centre, it was 109° at the back and sides, and 100° at the front; and while the glasses represented 103° on the upper trays, the lower ones represented 98°.

This at once accounted for my previous failures. I then closed up the draft in front, and, drawing the water out, bored holes through the tank in the back and sides, admitting ventilation where it was needed most, filling up the tank to just below the egg-trays. This evened up the heat in the egg-chamber to a great degree, and decidedly increased my percentage.

But this was not satisfactory; for though I was tolerably sure of from sixty to seventy per cent. of the eggs hatching, yet I could use but one tray, thus cutting the machine down to one-third its original capacity, which made a very expensive machine of it. I ran this incubator in connection with hens for a number of years, and they made about an even thing of it.

Sometimes, when I overslept myself, biddy would come out a little ahead; and again, when she would prove refractory, smash eggs, and give up the business just before the hatch was due, the odds would be in favor of the machine.

I was dissatisfied with this state of things. Sad experience had taught me what the requirements of a good incubator were. How to get them all in one machine was the difficulty. In the meantime, a number of new machines had been invented in different parts of the country, all claiming to do first-class work, and to completely supersede the old machines, which were denounced as worthless. The heat in these machines was regulated by batteries, thermostatic bars, etc., even to the fractional part of a degree. The machines were accompanied by testimonials from different parties, apparently genuine, claiming eighty, ninety, and even one hundred per cent. hatches.

I now thought my time had come. Though I had done fairly well with my machine for a number of years, yet I did not get first-class hatches, and there was altogether too much night work connected with it. I was ready to buy another machine, if it was as represented; and as some of them had drifted into the adjoining counties, I thought I would go and

interview the owners of these machines, and by personal investigation satisfy myself as to their merits.

One man said that he had put in a few eggs the first time, and hatched a pretty good percentage of them, and then filled up his machine, and somehow the battery got out of fix and he did not hatch anything, but at the present time it was running nicely.

On visiting another of different pattern (also run by battery), the operator said that he had put in a small number of eggs and hatched nearly one hundred per cent. (By the way *his* testimonial had particularly attracted my attention.) But when he had put in a large number of eggs his percentage was much smaller. In fact the greater the number of eggs the smaller was his percentage of hatch.

I thought of my own experience several years before. With the owner's permission I introduced glasses in different parts of the machine. It was as I expected; no uniformity of heat in the egg-chamber. The worst feature of my investigation was that there were very few chicks to be seen, and those few had a strong resemblance to some of mine I had got out in similar manner six or eight years before.

There was one exception, however. One man had about one thousand chicks, but as he had also some seventy-five or one hundred hens sitting at the same time, I was not sure of their origin. I did not find things as favorable as I expected, for on comparing notes the balance was decidedly in favor of my own machine.

Let it be here understood that I do not wish to detract anything from machines run by electricity. Some of these machines have become greatly improved, as well as their batteries, and are really doing good work. Others still have been more recently invented and now stand side by side with the older machines.

I had now either got to run the old machine or make something better myself. I had had experience enough in this business to know what the requirements of a good incubator were, but how to get them all into one machine and have them work together harmoniously was something that had puzzled brighter heads than mine.

Several machines were constructed in succession, with

gradual improvements in each, yet all with some defects. In 1878 a machine was built, regulated on an entirely different plan, making the very principle which generated the superfluous heat provide for its own escape. It worked to a charm; no more night work now. The first hatch was the best I had ever experienced. I obtained some four hundred chicks, or more than ninety per cent. of the fertile eggs; and I will here say that of the next two thousand chicks got out of that machine, not a hatch registered less than ninety per cent., and from that upwards, while my hens sitting on the same eggs and with the best of care I obtained less than sixty per cent. The question of success in artificial incubation was clearly settled in my mind. The use of hens for purposes of incubation was entirely discontinued.

I will not weary you with an account of the various experimental machines, run solely with a view to elucidate the scientific principles of artificial incubation. Carefully noting the necessary amount of heat, ventilation and moisture required in the different stages of development, — all this has been to me very interesting. It has, all told, required a great expenditure of labor and study, and called for much patient investigation; but the results attained have been highly gratifying.

It will be observed that, during the first part of my experience with incubators, my greatest trouble was to get chicks enough from them to supply my broody hens. During the latter part, the trouble was to get hens enough to care for the chicks.

When the hens were laying well, and there was a reasonable expectation of their soon becoming broody, machines were filled with eggs, anticipating that event. But I was so often disappointed that I have sometimes been obliged to put forty to fifty chicks to each hen. Of course a sad mortality was sure to follow. The situation was becoming desperate, and nearly as bad as at first. There was now no trouble in hatching. I could get out strong, healthy chicks in any desired quantity, but as I wished to get them out in winter, the question was, what to do with them.

In the autumn of 1879 I began the construction of artificial brooders, anticipating the winter's hatch. These

brooders were intended to accommodate about two hundred chicks. The heat was generated in copper boilers, flowed through an iron pipe, and returned to the boiler through a galvanized iron tank. This tank was eleven inches wide and five and one-half feet long, and supplied the heat to the chicks. I proposed to try one carefully, and satisfy myself as to its utility, before using them on a larger scale.

In pursuance of this plan, I chose one of my chicken houses, some seventy-five feet long, for the purpose. In one end of this building I put eight hens, giving them, in addition to what chicks they hatched themselves, one hundred chicks from an incubator started for the purpose. In the other end of this building I put a brooder, with one hundred and fifty chicks taken from the same incubator. They all received the same care, except that the hens' department got a great deal the most, because they needed it. Those chicks were hatched January 21. On May 25 following, when four months and four days old, the chicks were sent to market.

Of the one hundred and fifty brooder chicks, one hundred and thirty-five were matured, a number had died in the brooder, one or two were drowned, and, as brooder chicks are very tame, and my understanding unusually well-developed as a natural consequence quite a number were trodden upon. The largest chicks in the brooder weighed six and one-half pounds. The aggregate weight was six hundred and thirty-nine pounds, and the price received forty-five cents per pound live weight, amounting to $287.55.

Of these chicks which were consigned to the hens, ninety-eight were left. Their aggregate weight was three hundred and ninety-two pounds, which brought $176.40. Very few of those hens' chicks weighed over four pounds. It is needless to state that the brooders were brought into requisition at once.

After April 1 the brooders were located out of doors, in different parts of the yard. Hens were supplied with chicks and placed at a proper distance. All were properly cared for, as I was bound to see the experiment carried out through the entire season. In every case the advantage was with the brooders. Not only was the mortality less, but

the chicks were larger and their condition better. And strange to say, where the hens were located near the brooders, before the chicks were ten days old they would leave the hens and crowd into the brooder, and some hens had not a chick left. They had found where there was plenty of heat and no vermin.

That season's experience perfectly satisfied me in regard to the utility of brooders. I have made no use of hens since, as all I require of them is to furnish me with eggs.

I have grown annually, for the last ten years, from three thousand to five thousand ducks and chicks for the early market. This has been done in connection with, and supplementary to, other farm work. The chicks are taken from the machine when about twenty-four hours old, and should be fed for the first time about thirty-six hours after leaving the shell. The very best feed extant for that purpose is the infertile eggs boiled hard, chopped fine, and mixed with one part egg and three parts bread crumbs, for the first three days. Chicks will always thrive on this feed. After three days, the feed may consist of three parts Indian meal with one part shorts, scalded together.

This diet should be interspersed with green food, such as grass, chopped onions, boiled potatoes, refuse cabbage, etc. Cracked corn and wheat may be added as they grow older — say when ten days old.

Feed four or five times a day, when your chicks are first out, and never give them more than they can eat clean. Give a little meat occasionally, and, above all, give the young things plenty of exercise; everything depends upon that. Dig away the snow in front of your poultry buildings if in winter. The chicks will not need much urging; simply give them the opportunity to go out when the sun shines. Always recollect that the most active members of the body, either in man or animals, are the first to suffer from disuse, and that swollen feet and weak and crippled limbs in young chicks — though usually attributed to rheumatism — are simply caused by too highly concentrated food and too little exercise, thus causing a total want of action in the digestive organs, and the chicks literally starve in the midst of plenty.

Skim milk, either sweet or sour, is excellent for mixing

the feed. It will give young chicks a vigor and a growth in cold weather when other things fail. Plenty of clean water should be kept by them.

Brooders and runs should be cleaned out thoroughly and often, and the whole premises kept well disinfected.

In constructing suitable buildings for growing winter chicks, convenience as well as economy should be taken into consideration. For as labor is nearly the most expensive essential in a poultry establishment, buildings should be gotten up with a view to economize that, even if the original cost should be a little more. I am more and more satisfied that a walk three or four feet wide is a necessary adjunct to both poultry and chicken buildings of over thirty feet in length.

A good building for chicks in winter should be about fourteen feet wide, facing the south, with a four-foot walk on the rear side. It should be divided off into pens five feet wide, a brooder and fifty chicks in each. This would give a space five by ten feet to fifty chickens. There should be a yard of corresponding width in front for out-door exercise. This building can be extended to any desired length, and need not be more than two feet high in front, with say five-feet posts in the rear. It can be put up with an unequal double roof, with a ten-foot slope in front and a four-foot slope in the rear. The glass should be run from the eaves about six feet up the slope in front, and need not occupy more than one-half the longitudinal space on the roof.

Ventilation should lead from out the floor up through the peak, and will come up by the partition which separates the chicks from the walk. The sashes should be so adjusted as to slide, and give additional ventilation during extreme warm weather, and so arranged that they can be operated upon from the walk.

Opinion is about equally divided as to the best and most economical method of heating a chicken house. Many prefer to heat with hot-house boilers, running hot water through the whole length of the building, and utilizing the heat from the flow and return pipes as brooders for the chicks. There is no doubt but that this system will work well, but it is too expensive for a man with but little or no capital, as it will

cost nearly as much as the whole building. Nor is the first cost the whole expense attending it, for if you have but fifty chicks it necessitates heating the whole building; whereas, by the system of separate brooders in each pen, one cent's worth of oil will furnish heat for fifty chicks, so that your expense can be exactly proportioned to the number of chicks. Besides, a complement of brooders can be furnished at less than one-fourth the cost of boiler and pipes.

The best time to hatch chicks for broilers is in January and February. Hold them until the first of June, or until just before the price falls, getting all the weight on them you can. Good chicks, well cared for, should weigh at four months old ten pounds per pair. Chicks of that size will always sell much more readily than smaller ones, and at better prices, as the market is always full of the latter size.

I have often heard people say that chicks got out in April were early enough for them. I once heard a prominent poultry grower say that he would not give a cent to get out a chick before the first of April. Perhaps it would be as well to expose that error now as at any time. There is not a farmer present but what knows that the first hundred pounds put on a young animal, whether of beef or pork, costs a great deal more than the last hundred pounds when the animal is ready for the shambles. The same rule holds good with poultry, only much more so. I can easily put the last three pounds on a five-pound chick, when all risk from mortality is gone, for five cents per pound, but I want ten cents to put on the first two pounds. But this is not all. A prominent Boston dealer, about the middle of July, when asked how chicks sold, told me that there was a big demand for four-pound roasters, but that the market was glutted with chicks weighing three or four pounds per pair. Said he: "There is a box of chicks of the latter kind we are retailing for twenty-seven cents per pound. There is a box of four-pound chicks that I got from Natick this morning that I paid forty cents per pound for, and we are retailing the best of them for sixty cents." I cannot sell chicks weighing two and three pounds for anything like a satisfactory price, but when I get them out early and weighing four to five pounds, I get just about what I want for them.

The reason is obvious. There is a rapid decline in the market. From the middle of June to the first of September your two-pound chick, if you can only sell him, will bring you as many dollars and cents as your three-pound three weeks later. The extra pound will not compensate for the fall in the market, hence the frantic efforts to force small chicks on the market.

It will readily be seen by this that the profits on one chick got out in January and February are more than the profits on five chicks got out in June and July. Indeed, no one can afford to hatch chicks during the summer months, as the extreme heat will reduce the size and vitality of chicks far more than the cold of the early spring months. Then, as they are always sure to be off condition, the price is always low, compared to the more robust chicks got out earlier in the season.

Chicks hatched before the first of March should all be sold, both pullets and crowers, otherwise the pullets will lay in July and August, and would moult in the fall, the same as an old hen, and one can hardly afford to keep a two-dollar pullet idle through the winter, and then sell her for less than half that sum in the spring.

The proper time to hatch out Asiatics for winter layers is in March and April, while the Leghorns and smaller breeds will do as well in April and May, and even the first of June.

During the months of January and February my machines were run entirely on hens' eggs, and our buildings were filled with chicks, all intended for market. During March the machines are run to their utmost capacity on ducks' eggs. During April, the incubators are run largely on hens' eggs, to furnish store fowls for winter laying. Then in May and June they are run entirely on ducks.

Brooders are especially convenient in growing ducks, as the ducklings seldom need heat more than ten days.

The raising of ducks for market is a business which I supplement to my chicken business. I find it, if anything, more profitable than chicken raising, as the ducks can be hatched and grown artificially with far less care and trouble, and with much smaller percentage of loss, than when grown under hens.

I have got out, the present summer, some three thousand ducklings, and can truly say that from the first fifteen hundred I lost but one duck.

These ducks simply require water to drink, and are fed nearly the same as chickens, except that they need rather more animal food as they increase in size. They should be carefully guarded from the rain for the first fortnight. They should also be yarded while young, for, if allowed free range, they greedily devour all manner of insects, which they do not stop to kill, and too often pay the penalty with their lives. Boiled potatoes and vegetables should be fed freely at least once a day to young ducks; they should have four meals each day until five weeks old. Cracked corn and refuse wheat may be kept by them, but while fattening they should have all the soft food they can eat at least three times a day.

Ducks should be marketed at nine or ten weeks old, as soon after that the pin feathers begin to grow, and they are off condition and soon become poor, while it is an immense job to pick them. If not marketed at the time above mentioned, they will not be in condition again till after they are four months old. Pekin ducks at nine weeks old, if well fed, will dress from eight to eleven pounds per pair. I obtained for the first lot sold this season, $3 per pair. At present (June 15), the Boston dealers return $2 per pair.

An idea may be formed of the profits connected with the business, when a careful estimate places the cost of growing a duck at less than twenty-two cents per head up to nine weeks old. Ducks will stand close confinement far better than chicks, are voracious eaters, and are not particular as to the quality; and to my mind a pair of nicely roasted young ducks is excelled by nothing in the poultry or game line, and is a dish fit for an epicure.

Store ducks should be kept in a warm place and fed liberally to induce early laying. The incubator should be filled with these eggs as early in spring as may be, as the sooner the young ducklings are hatched the higher the prices obtained. Yet, unlike chicks, they are very profitable when hatched out as late as the first of August. I hatch most of my ducks in May and June, when the hatch of chicks is con-

cluded and the machines would otherwise be idle. As fast as the spring broilers go to market, the buildings are filled right up with ducklings. Now as ducks will be as heavy at eight weeks as chicks at eighteen weeks, it will be readily seen that the one business does not necessarily interfere with the other.

Up to the present time of writing (June 15), I have some two thousand ducklings out. Quite a number of these ducklings have already been marketed, dressing from ten to eleven pounds per pair at nine weeks old. As these ducks bring thirty cents per pound at wholesale prices in Boston, and cost but five cents per pound to grow them, it is easy to see that it is a paying business. I do not lose more than one per cent. of the ducklings when they are properly cared for, my hatches running from ninety to ninety-eight per cent. of fertile eggs.

Poultry Buildings.

I am often asked to give a plan for practical poultry buildings. This is a very difficult thing to do, because some people want their buildings very ornamental, while others, whose purses are lighter, want structures that are barely practicable. Some have plenty of room, and can colonize their fowls out, in small or portable buildings, and give them plenty of range; this, all things considered, is the best method.

Others still are limited for room and would like to know how many fowls they can keep to advantage on a given area. Now these different situations require differently constructed buildings.

Then, again, the labor question, as connected with the poultry business, is one of the gravest import. It is now difficult to get faithful, intelligent help. The old impression that boys and girls and invalids are adapted to the care of poultry is fast wearing away. The poultry business means long days, early work and late; and there is not only a large amount of drudgery connected with it, but it is a work of detail, as well as requiring constant vigilance and activity.

Hence, in all poultry establishments, got up with a view to profit, the buildings should be constructed with a view to

simplifying the labor question, and every facility allowed for cleaning and purifying. The sanitary department comes first on the list, for where poultry are reared on a large scale the predisposition to vermin and disease is in exact ratio to the number kept; especially is this the case where the fowl are confined.

Ventilation should always be from below, as this carries away the cold air and foul gases, instead of the warm, pure air of the upper stratum. A person has only to pass through a building occupied by fowls and ventilated in either of the above ways to satisfy himself of the utility of the bottom ventilation.

Where one is limited in space, and large buildings are necessary, undoubtedly a double-roof building twenty-four feet wide, with a four foot walk in the centre, is the most convenient and best. This building need not be more than four feet high at the sides, and can be of any required length. There should be a pump connected with this aisle, and the fowls should all be fed and watered from it. This reduces the labor and care to a minimum.

By this arrangement an hour each morning and evening would be all the time required to feed and water one thousand fowls. Of course, a building of this description one hundred feet long would be ample accommodations for five hundred fowl. Such a building need not cost over $275, but can be made to cost twice that sum. The fowl should have access to small dust-rooms, and the nests should be arranged so that the eggs can be gathered from the walk. The whole thing should be got up with a view to simplify the labor and sanitary departments, as constant cleanliness is absolutely necessary to success.

I will give my balance sheet for 1882 and 1883 on chicks: —

Stock on hand Sept. 1, 1882.

314 pullets, at $1.25 each,	$392 50
Supplies and food of all kinds,	754 31
95 gallons oil,	7 60
	$1,154 41

Stock on hand Sept. 1, 1883.

634 pullets and chicks,	$536 50
1,616 dozen eggs sold,	533 28
302 hens sold,	314 75
1,434 chicks sold,	1,400 01
	$2,784 54
Net profit,	1,630 13

This showing gives a clear profit per hen of $5.20.

I would here say that the care of this poultry devolved entirely on myself. While my men were milking and feeding stock in the barn, I cared for chicks and machines, and seven o'clock found me at work in the field; and, with the exception of a half hour in the middle of each forenoon and afternoon, devoted to feeding chicks, I did my share of field work with the others.

I will give an account of my little duck venture for 1885:—

Stock on hand Jan. 1, 1885.

42 ducks and drakes, at $1.50 each,	$63 00
Feed of all kinds consumed,	334 52
68 gallons oil, at 8½c. per gal.,	5 78
	$403 30

Stock on hand Dec. 1, 1885.

206 ducks and drakes, at $1.50 each,	$309 00
Ducks sold,	1,503 71
72 dozen eggs sold,	61 00
121 lbs. feathers sold, at 50c.,	60 50
	$1,934 21
Net profit,	1,530 91

Or a profit of nearly $44 to each duck. This profit might have been increased had I hatched rather than sold the eggs above mentioned. I think that every one here will concede that the above showing by the "old hen process" would have been next to impossible.

I am not here alone to show that the poultry business offers to the New England farmer a branch of industry far more profitable than any other in which he can engage, but to prove to you conclusively the immense superiority of the artificial over the natural way of doing it. The absolute certainty with which one can calculate upon good results, the great saving of eggs in the much better percentage of hatch obtained through machinery, the great economy of labor of the artificial over the natural method where one man can easily do the work of three; these points, together with the total immunity from the perplexity and care attendant upon the use of refractory hens, make the superiority of the artificial over the natural evident to all.

Many of you doubtless recollect, when visiting the "Mechanics' Fair" in Boston a year or two ago, that a space in one side of that huge building was devoted to the manufacture of boots and shoes, and how that whole sides of leather were introduced in one side of that building, and in fifteen minutes came out polished boots and shoes at the other. You recollect also that on a platform above that wonderful machinery (and representing the old-time method) sat a superannuated old octogenarian, his visage solemn as an owl, his mouth full of pegs, pegging away for dear life; and how the throngs of visitors that gathered around were convulsed with laughter at the ludicrous contrast. There is just as much difference to-day between the natural and artificial methods of growing poultry as there is between handwork and machinery in the manufacture of our boots and shoes.

There has been a great revolution in New England farming within the past thirty years. Our sterile soil cannot compete favorably with the West and its interminable area of inexhaustible fertility, or with the sunny South and its semi-tropical clime, which gluts our markets with our own fruits ere our blossoms open. The same crops that sufficed for the frugal wants of the farmer's family thirty years ago are wholly inadequate to meet the increased expenses and more luxurious tastes of to-day. As a natural consequence the young men, discouraged by the outlook, are going West, filling our shops and factories, or vainly seeking salaried

positions in our cities, leaving the old gentleman, by dint of muscle and machinery, to get along as best he can, and when, according to the natural course of things, the gray-haired sire pays the debt of nature, the farm is placed upon the market for less than the actual cost of the buildings. There are thousands of New England farms to-day on the market for less than the actual value of the buildings. Our daughters and our wives (the hard-working mothers of our children), though on the farm, have the same refined tastes, the same love of the beautiful and the good, the same desires that their city sisters have, but too often without the opportunity to gratify them, and there is not a shadow of a reason why they should not be gratified. There are hundreds of farmers in New England to-day who are burdened with toil and debt. They are still travelling in the old ruts and cannot be induced to clamber out. They will persist in raising the old complement of potatoes and corn, of growing the same amount of beef and pork, of making the usual quantity of second or third quality butter, and in keeping the same number of half-starved, nude old hens and then wonder why they don't lay. They will not see that a pound of chicken or duck (which can be grown in three months at a far less cost than a pound of either beef or pork, and which, when put upon the market, will bring four times as much) is the best crop for them to raise. There is absolutely nothing within the possibilities of farm industry that is capable of making so rich returns as poultry-growing when artificially conducted. Every New England farm should have its poultry department, the same as its dairy or vegetable department. It is far easier now to fence against poultry than against cattle, sheep or swine, while the returns are four times as great as in either, with far less capital and labor involved. A well conducted poultry yard gives a most promising outlook to the young men, with encouragement to stand by their gray-haired sire on the farm. It gives profitable and healthful employment to the daughter, with the means of gratifying her innocent tastes, of acquiring those nameless gifts and graces which render the American girl of to-day so attractive to all. It means to the

hard-working mother immunity from toil, all of the necessaries of life, together with a large share of its luxuries, with a happy fireside for all on the farm.

Mr. C. A. Smith of Colrain. Lest the discussion which may follow the lecture which we have just heard may continue after many of the members of the Board are under the necessity of leaving, I want, in behalf of the Board of Agriculture, to offer a resolution thanking the people of Framingham for their cordial entertainment of the Board, and also expressing the thanks of the Board to the essayists for their instructive papers. I think I speak for every member of the Board when I say that this has been one of the most interesting meetings ever held, and the subjects under discussion have been dealt with in a most thorough and complete manner.

The Chairman. Before putting the question I would like to say, that while we have received the kindest and most hospitable attention in every place that we have visited as a Board, personally I have never known a time when I myself, and many with whom I am personally acquainted, have received such princely accommodations and attentions as many of us have received from citizens in the town of Framingham; and at the hotel we have been abundantly provided for and our wants attended to in every respect.

Secretary Russell. I fully agree with what has been said, and join in thankfulness to the good people of Framingham who have taken an interest in this meeting, but I want to express my great regret that papers so valuable, upon subjects so vital, have drawn but a fraction of the people of this region to hear them. We have discussed a subject here this morning, — the matter of poultry and eggs, — that, in its value to this country, exceeds all the production of wool, all the production of iron, all the production of silver and gold taken from the mines. And yet it is a subject that, as you see, has drawn but an infinitesimal number of people here in this crowded community to hear what is said about it. I hope that the day will come when my successor in the position of Secretary of the State Board of Agriculture, when he gets up a meeting with the care, pains

and trouble with which this has been gotten up, will be rewarded by seeing thronging crowds of people, — thousands instead of dozens. (Applause.)

The question was then put on the vote proposed by Mr. Smith and it was carried unanimously.

(Mr. BIRD in the chair.)

The CHAIRMAN. Now, gentlemen, any question relative to the poultry interest will be in order.

Mr. BIGELOW of Framingham. I would like to inquire whether the chickens that are hatched by this perfected incubator break the shells themselves or whether they need any assistance.

Mr. RANKIN. They break the eggs themselves. All we have to do is to take out the chicks and the egg-shells after they have parted company.

Mr. ——. I would like to ask the gentleman if he can tell us why chickens will sometimes come to full development and still be found dead in the shell?

Mr. RANKIN. The main trouble is want of moisture the latter part of the hatch. As a general thing, in all machines that generate their own moisture, where there is a good deal of animal heat in the chicks, there is not nearly so much moisture generated the latter part of the hatch as at the early part, when it is most needed. Sometimes it may be owing to some want of vitality in the fowl from which the egg comes; but generally it is due to a lack of moisture, which causes the lining of the shell to harden, and this clogs the egg-shell like rubber.

QUESTION. What breed is best adapted to raising chickens for the market? Do you discover any difference in the hatching of eggs of different breeds by artificial heat?

Mr. RANKIN. There is quite a difference in hatching. The Brahma egg is the most difficult, as a general thing. Leghorn eggs are the best to raise chickens for the market. Leghorn eggs will hatch like popcorn; there seems to be no trouble about it. A cross between Brahmas and Plymouth Rocks makes an excellent fowl.

Mr. WARE. I would like to inquire the breed of ducks from which you netted a profit of $44 a head.

Mr. Rankin. Pekin ducks.

Mr. Pendleton of Wayland. Have you made any improvements in your incubator since a year ago last January?

Mr. Rankin. I have, sir; but I am not here to represent any particular incubator, but simply artificial incubation.

Mr. Pendleton. I have seen quite a number of different kinds of incubators, and I have not seen any one that I liked as well as the one which I purchased of you; but there are a few little points about the machine which I understood you had improved upon. We ran the incubator three times last winter, and we also set at one time fifty hens. The incubator beat the hens; but our eggs last winter were not as fertile as they generally are. I would like to know if there are any here who had the same trouble.

Mr. Rankin. In any winter when the ground is covered with ice and snow for a great length of time, it will interfere sadly with the fertility of the eggs, because it necessitates confinement of the fowl. That is always the case.

Mr. Edson. I think the gentleman has been very thorough and very explicit in most of his explanations in regard to setting fowls; but I would like to inquire if the artificial heat of his incubator is obtained directly from a lamp or by hot water.

Mr. Rankin. By hot water.

Mr. Edson. I wish you would explain a little more fully your mode of operation in regard to it, in connection with the subject of ventilation. I wish you would give us a little more instruction about that.

Mr. Rankin. We use very little ventilation indeed. It is not necessary to use much ventilation, and it is an injury, because it carries off the moisture which is needed in the egg-chamber.

Mr. Edson. What apparatus do you use for heating?

Mr. Rankin. The principle is the same in all machines. The water simply goes through a boiler. It is the same principle as a hot-house boiler, or the hot water in a house.

Mr. Edson. It is not direct heat from the lamp?

Mr. Rankin. No, sir; radiation from metallic surfaces.

Mr. Ware. Is water applied within the incubator to supply moisture to the eggs?

Mr. Rankin. Water is evaporated in the egg-chamber, causing constant moisture automatically.

The Chairman. Is there anything further, gentlemen? If not we will close the meeting. I desire to thank all for their presence here, for their interest, and for their attention, and hope that at some time not in the distant future the Board will again select Framingham as its place of meeting.

Adjourned.

ANNUAL MEETING OF THE BOARD.

ANNUAL REPORT.

The Board met at the office of the Secretary, in Boston, Tuesday, Feb. 2, 1886, at 12 o'clock, M., and was called to order by the Secretary, and, in the absence of the Governor, Hon. Marshall P. Wilder took the chair.

Present: Messrs. Bird, Bowen, Bowditch, Brooks, Burgess, Buddington, Cushman, Damon, Edson, Grinnell, Goddard, Goodrich, Hartshorn, Hersey, Hill, Lynde, Moore, Nye, Owen, Porter, Slade, Sessions, A. A. Smith, Upton, Varnum, Warner, Wheeler and Wilder.

Voted, To adopt the order of business used at the previous annual meeting.

Voted, To dispense with the reading of the minutes of the last meeting, the matter having all been printed in the annual report of 1884.

Voted, To appoint a committee of three to examine and report on the credentials of newly elected members: Messrs. Hartshorn, Hill and Bowen.

Reports of delegates being then in order, Mr. Buddington reported on the Amesbury and Salisbury Society; Mr. Upton reported on the Barnstable; Mr. Warner reported on the Berkshire.

The Committee on Credentials, to which was referred the credentials of newly elected members, reported the following duly elected: —

Hon. Marshall P. Wilder, appointed by the Executive.
Zeri Smith of Deerfield, by the Franklin Society.
Wm. W. Smith of Amherst, by the Hampshire Society.

Henry L. Whiting of West Tisbury, by the Martha's Vineyard Society.

S. A. Bartholomew of North Blandford, by the Union Society.

Bainbridge Douty of Charlton, by the Worcester South Society.

A. C. Varnum of Lowell, by the Middlesex North Society.

J. P. Lynde of Athol, by the Worcester Northwest Society.

Nathan Edson of Barnstable, by the Barnstable Society.

Velorous Taft, in place of George W. Hobbs, by the Blackstone Valley Society.

Mr. Bowen reported on the Blackstone Valley Society. Mr. Damon reported on the Deerfield Valley.

The Board then adjourned until 2.30 P.M.

The Board was called to order at 2.30 P.M., Mr. GRINNELL in the chair.

Mr. Damon's report on the Deerfield Valley Society was taken from the table, and that portion relating to potato culture was discussed, Messrs. Hartshorn, Upton, Hersey, Wheeler, Sessions, Bartholomew, Grinnell and Damon participating in the discussion.

Also, the question of attaching or not attaching tags to exhibits at fairs, with names instead of numbers, was discussed by Messrs. Smith, Hartshorn, Hersey, Warner and others.

No action was taken by the Board on either question. Mr. Damon's report was accepted.

Mr. Goddard reported on the Hampden Society; Mr. Edson reported on the Hampden East; Mr. Nye reported on the Hampshire, Franklin and Hampden; Mr. Hartshorn reported on the Highland.

Owing to the death of Mr. Lane no report was made on the Hingham Society.

Mr. Owen reported on the Hoosac Valley Society; Mr. Brooks reported on the Marshfield; Mr. Owen reported on the Martha's Vineyard; Mr. Burgess reported on the Middlesex; Mr. Wheeler reported on the Middlesex North; Mr. A. A. Smith reported on the Nantucket.

The Board adjourned at 4.30 P.M.

SECOND DAY.

The Board met at 9.30 A.M., Mr. GRINNELL in the chair.

Present: Messrs. Barrus, Bartholomew, Bird, Bowen, Bowditch, Brooks, Burgess, Cushman, Damon, Douty, Edson, Grinnell, Goddard, Goodrich, Goessmann, Hartshorn, Hersey, Hill, Lynde, Moore, Owen, Porter, Slade, Sessions, A. A. Smith, Wm. W. Smith, Zeri Smith, Taft, Upton, Varnum, Wheeler, Wilder and Wood.

The minutes of the previous day were read and approved.

Voted, To appoint a committee of three on the assignment of delegates to the annual fairs: Messrs. Damon, Goddard and Douty.

Voted, To appoint a committee upon changes in time for holding fairs: Messrs. Varnum, Edson and Ware.

Voted, To appoint a committee of five on time and place for holding the country meeting: Messrs. Moore, Slade, Smith, Wheeler and Hill.

Reports of delegates being in order, Mr. Ware reported on the Plymouth Society; Mr. Wood reported on the Housatonic; Mr. Hersey reported on the Union; Mr. Hill reported on the Worcester; Mr. Grinnell reported on the Worcester North; Mr. Varnum reported on the Worcester Northwest; Mr. Slade reported on the Worcester South; Mr. Porter reported on the Worcester West; Mr. Grinnell reported on the Massachusetts Horticultural; Mr. McKinstry reported on the Bristol County; Mr. Barrus reported on the Middlesex South.

Mr. Hersey addressed the chair upon the death of Mr. John Lane, and moved that the Secretary be instructed to communicate to the family the fact that the loss of Mr. Lane was remembered and deplored by the Board in session.

The motion was seconded, with a warm tribute to the character of Mr. Lane, paid by his successor on the Board, Mr. Cushman.

Mr. Wilder also spoke upon the same theme.

Mr. Hersey's motion was carried.

Voted, To appoint a committee of three on essays: Messrs. Lynde, A. A. Smith and Sessions.

Mr. Bowditch read an essay on Raising Calves. This essay was discussed by Messrs. Sessions, Cushing, Wheeler, Upton and Goessmann, and adopted.

Mr. Brooks read an essay on Farm Life, which was adopted.

Prof. Goessmann made his annual report on Commercial Fertilizers, which was adopted after discussion.

The Secretary submitted a letter from Mr. Charles E. Dewey, in which complaint was made of loose management at some of the county fairs in regard to awarding premiums on bulls, premiums being granted upon insufficient proof of thorough breeding.

The complaints of Mr. Dewey's letter were corroborated by Messrs. Sessions, Bowditch and Upton, and the matter was generally discussed until 1.30, when it was laid on the table.

Rev. Charles B. Rice of Danvers, appeared before the Board and advocated that the Board should use its influence to procure legislation to compel a concerted action in regions infested by canker worms, to insure their destruction.

The matter, after discussion by Messrs. Moore, Douty, Hersey and others, was laid on the table.

The Board then adjourned.

THIRD DAY.

The Board met at 9.30 A.M., Mr. GRINNELL in the chair.

Present: Messrs. Barrus, Bartholomew, Bird, Bowen, Bowditch, Brooks, Burgess, Cushman, Damon, Douty, Edson, Grinnell, Goessmann, Hartshorn, Hersey, Hill, Lynde,

Moore, Porter, Slade, Sessions, A. A. Smith, Wm. W. Smith, Zeri Smith, Taft, Upton, Varnum, Wheeler, Wilder and Wood.

Minutes of the previous day were read and accepted.

Mr. Damon, for the Committee on Assignment of Delegates, reported as follows: —

Amesbury and Salisbury, . . .	Edmund Hersey.
Barnstable, ...	Ethan Brooks.
Berkshire, ...	J D. Porter.
Blackstone Valley, ...	W. W. Smith.
Bristol, ...	E F. Bowditch.
Deerfield Valley, ...	H. M. Owen.
Essex, ...	A. C. Varnum.
Franklin, ...	Elbridge Cushman.
Hampden, ...	J. H. Hill.
Hampden East, ...	A. P. Slade.
Hampshire, ...	S. B. Bird.
Hampshire, Franklin and Hampden, .	J. S. Grinnell.
Highland, ...	Zeri Smith.
Hingham, ...	W. S. Bowen.
Hoosac Valley, ...	B. Douty.
Housatonic, ...	Daniel E. Damon.
Hillside, ...	C. L. Hartshorn.
Massachusetts Horticultural, . .	J. P. Lynde.
Marshfield, ...	V. Taft.
Martha's Vineyard, ...	M. I. Wheeler.
Middlesex, ...	D. L. Bartholomew.
Middlesex North, ...	N. Edson.
Middlesex South, ...	R. E. Burgess.
Nantucket, ...	J. B. Moore.
Plymouth, ...	J. H. Goddard.
Union, ...	E. W. Wood.
Worcester, ...	A. Barrus.
Worcester North, ...	A. A. Smith.
Worcester North-west, . . .	Benj. P. Ware.
Worcester South, ...	D. Upton.
Worcester West, ...	W. R. Sessions.

Mr. A. A. Smith, for the Committee on Essays, reported as follows: —

E. W. Wood. "Fruit."

M. I. Wheeler. "The Management of an Agricultural Fair."

A. C. Varnum. "The Effect of Farm Life upon the Manhood of the Boy."

D. E. Damon. Upon a subject to be announced.

The report was accepted.

Mr. Varnum, for the Committee on Changes of Times for Holding Fairs, reported as follows: —

DEERFIELD VALLEY SOCIETY, 2d Thursday after the 1st Monday in September.

HAMPDEN EAST SOCIETY, 2d Tuesday after the 1st Monday in September.

UNION SOCIETY, 2d Wednesday after the 1st Monday in September.

WORCESTER NORTHWEST SOCIETY, 3d Tuesday after the 1st Monday in September.

WORCESTER SOUTH SOCIETY, 2d Thursday after the 1st Monday in September.

The report was accepted.

Mr. Moore, from Committee on Time and Place for holding Country Meeting, reported that the Country Meeting should be held at Barre, Tuesday, November 30. The report was accepted.

An election was held for member of the Board of Control of the Experiment Station. Dr. Lynde was unanimously elected.

An election was held for Secretary of the Board. Mr. Russell was re-elected.

Mr. Varnum reported from the Examining Committee of the Agricultural College, in writing and in full, as directed by the Board at previous meetings. It was adopted and ordered to be printed.

The election of two members of the Examining Committee of the College being next in order, H. L. Whiting and A. C. Varnum were chosen.

Messrs. Goddard, Hartshorn, Douty, Lynde and Goodrich were appointed a Committee on the Country Meeting.

Report of Treasurer of the Experiment Station was read by the Treasurer and laid on the table.

On motion of Mr. Moore it was

Voted, That the Experiment Station, in the judgment of this Board, should be separated from any connection with the Massachusetts Agricultural College, except such as can be readily afforded in an educational view and without expense to the Experiment Station. And in consideration of such educational advantages, the College shall sell or lease to the Station such land as may be needed by the Experiment Station, at a nominal price; and that a committee of three members of this Board be appointed to attend a meeting of the Committee on Agriculture of the Legislature, to advocate the above vote. Messrs. Moore, Hartshorn and Damon were appointed.

An Executive Committee and Committee on Printing was chosen by ballot: Messrs. Wilder, Slade, Hartshorn, Hersey and Bowditch.

The reports of delegates that were upon the table were taken up, read by their titles and adopted.

Voted, That all unfinished business be referred to the Executive Committee, with full powers.

Adjourned.

JOHN E. RUSSELL,
Secretary.

THE FINANCES OF THE SOCIETIES.

FINANCES OF THE SOCIETIES.

SOCIETIES.	Amount received from the Commonwealth.	Income from Permanent Fund.	New Members and Donations.	All other Sources.	Receipts for the Year.	Premiums Offered.	Premiums and Gratuities Paid.	Current Expenses for the Year, not including Premiums and Gratuities Paid.	Disbursements for the Year.	Indebtedness.	Value of Real Estate.	Value of Personal Estate.	Permanent Fund.
Amesbury and Salisbury, . .	$261 05	$61 29	$79 00	$322 63	$759 97	$401 00	$269 25	$283 71	$552 96	-	$300 00	-	$1,436 73
Barnstable, . .	600 00	16 00	172 10	1,645 56	2,433 66	1,268 00	928 00	757 09	1,685 90	-	5,000 00	$500 00	5,500 00
Berkshire, . .	600 00	574 11	274 00	4,159 25	-	3,607 00	3,227 00	2,237 75	-	$1,200 00	8,000 00	500 00	8,500 00
Bristol, . . .	600 00	-	433 10	-	11,516 38	5,000 00	4,489 50	6,087 99	11,901 59	14,000 00	46,000 00	300 00	31,700 00
Blackstone Valley,	187 92	-	54 73	1,113 60	1,356 25	386 00	332 38	470 17	1,316 05	1,300 00	3,000 00	335 41	3,335 41
Deerfield Valley, .	600 00	-	265 60	1,236 10	2,101 70	825 00	769 15	636 77	1,405 92	-	8,080 00	800 00	8,880 00
Essex, . . .	600 00	795 10	162 50	769 97	2,627 57	2,966 00	1,380 50	809 60	2,307 60	-	5,000 00	1,000 00	18,303 05
Franklin, . .	600 00	-	206 00	1,463 71	2,269 71	990 00	813 91	601 25	1,415 16	-	10,000 00	1,000 00	11,000 00
Hampden, . .	578 28	-	41 00	256 37	875 65	2,190 25	603 77	342 14	945 91	-	-	-	-
Hampden East, .	600 00	-	147 06	832 54	1,579 60	1,335 25	962 15	484 44	1,446 59	175 00	5,000 00	-	5,000 00
Hampshire, . .	600 00	-	131 79	792 19	1,523 98	811 00	656 85	579 13	1,428 98	-	4,100 00	150 00	3,300 00
Hampshire, Franklin and Hampden,	600 00	151 45	72 00	2,500 86	3,324 31	1,187 50	725 00	1,654 09	2,987 84	5,933 33	7,800 00	478 47	8,278 47
Highland, . .	600 00	-	60 00	1,870 30	2,530 32	914 80	687 40	1,823 64	2,511 04	-	3,000 00	100 00	3,100 00
Hingham, . .	600 00	-	278 65	2,338 49	3,217 14	1,677 05	668 45	2,495 22	3,163 67	500 00	16,000 00	2,000 00	18,000 00
Hoosac Valley, .	600 00	-	115 00	3,084 95	3,799 95	1,785 50	1,371 00	1,818 01	3,189 01	3,600 00	12,900 00	1,438 86	14,338 86
Housatonic, . .	600 00	1,370 46	288 34	4,399 77	6,658 57	3,886 00	3,427 00	2,704 73	6,157 18	-	8,500 00	1,169 05	9,669 05
Hillside, . . .	600 00	121 58	736 77	1,111 76	2,570 11	650 00	627 05	1,970 11	2,597 16	800 00	3,817 41	702 17	3,719 58
Marshfield, . .	600 00	-	30 95	1,833 33	2,464 28	1,175 50	906 51	1,334 19	2,360 30	4,702 48	11,806 00	1,392 78	8,497 72
Martha's Vineyard,	600 00	176 24	40 00	232 58	1,049 82	770 50	723 60	456 01	1,179 61	-	2,200 00	1,570 00	3,770 00
Middlesex, . .	600 00	-	140 00	2,364 55	-	1,484 00	786 25	1,745 90	2,532 15	21,000 00	15,000 00	-	3,000 00
Middlesex North, .	600 00	460 50	49 00	1,001 95	1,984 20	1,126 00	607 05	1,360 97	1,968 02	1,200 00	20,000 00	150 00	20,000 00
Middlesex South, .	600 00	-	98 37	1,098 18	1,796 55	1,105 00	763 77	479 28	1,300 42	13,500 00	18,000 00	1,500 00	6,000 00
Nantucket, . .	600 00	40 00	13 00	346 32	997 67	1,247 00	567 75	479 55	1,080 45	400 00	3,000 00	200 00	3,200 00
Plymouth, . .	600 00	200 00	136 20	3,706 59	4,642 79	3,085 50	2,366 85	2,060 39	4,427 24	7,850 00	43,000 00	2,000 00	40,000 00
Union, . . .	600 00	-	188 59	1,586 23	2,293 23	1,343 00	865 91	1,047 14	1,913 05	-	6,697 59	2,297 57	8,995 16
Worcester, . .	600 00	647 28	915 18	2,746 95	4,909 40	2,895 00	1,668 97	1,792 62	4,899 87	40,000 00	120,000 00	5,000 00	100,000 00

Worcester North, .	600 00	-	144 15	1,847 83	2,152 10	1,376 50	1,192 26	1,456 95	2,531 06	10,967 50	16,000 00	100 00	128 84
Worcester North-West, . . .	600 00	-	137 50	2,954 10	3,691 60	1,785 75	1,307 70	2,264 45	4,772 15	3,300 00	13,000 00	957 12	10,657 12
Worcester South, .	600 00	3,564 11	275 00	200 00	4,639 11	2,500 00	1,883 90	1,279 10	3,991 00	-	14,000 00	1,000 00	14,000 00
Worcester West, .	600 00	221 65	73 51	1,361 00	2,212 65	1,484 60	1,186 14	772 08	2,378 22	786 99	11,600 00	750 00	11,600 00
Massachusetts Horticultural, . .	-	-	1,090 00	2,713 53	35,484 22	4,646 00	3,356 00	25,767 71	29,123 71	72,000 00	240,000 00	-	180,000 00
	$17,227 25	$8,399 77	$6,849 09	$51,891 19	$117,442 49	$55,904 70	$40,121 02	$68,052 18	$109,469 81	$203,215 30	$680,801 00	$27,391 43	$563,909 99

PERMANENT FUND — HOW INVESTED.

AMESBURY AND SALISBURY. — Deposited in bank.
BARNSTABLE. — Real estate and government bonds.
BERKSHIRE. — Real estate.
BLACKSTONE VALLEY. — Real estate.
BRISTOL. — Real estate.
DEERFIELD VALLEY. — Bank funds and real estate.
ESSEX. — Bank stock and farm.
FRANKLIN. — Bank stock and real estate.
HAMPDEN. —
HAMPDEN EAST. — In land and buildings.
HAMPSHIRE. — In real estate.
HAMPSHIRE, FRANKLIN AND HAMPDEN. — In real estate.
HIGHLAND. — Bank stock and real estate.
HILLSIDE. — In land and buildings.
HINGHAM. — In land and buildings.
HOOSAC VALLEY. — Real estate.
HOUSATONIC. — Real estate, railroad bonds, bank funds.
MARSHFIELD. — In land and buildings.
MARTHA'S VINEYARD. — In land and buildings.
MASSACHUSETTS HORTICULTURAL. — In real estate.
MIDDLESEX. —
MIDDLESEX NORTH. — In land and buildings.
MIDDLESEX SOUTH. — In land and buildings.
NANTUCKET. — In land and buildings.
PLYMOUTH. — In real estate.
UNION. — Real estate and cash.
WORCESTER. — Real estate.
WORCESTER NORTH. — Real estate and cash.
WORCESTER NORTH-WEST. — In land and buildings.
WORCESTER SOUTH. — In land and buildings.
WORCESTER WEST. — In real estate.

ANALYSIS OF PREMIUMS AND GRATUITIES AWARDED.

SOCIETIES.	Total Amount offered for Management and Improvement of Farms, Orchards, etc.	Total Amount paid for Management and Improvement of Farms, Orchards, etc.	For Neat and Dairy Stock.	For Horses.	For all other Farm Stock.	Total Amount offered for Live Steck.	Total Amount paid out for Live Stock.	For Cereals and Seeds.	For Roots and Vegetables.	Total Amount offered for Grain and Root Crop.	Total Amount paid out for Grain and Root Crop.	For Fruits, Flowers, etc.	For Dairy Products.	For Bread, Honey and Preserved Fruits, etc.	Total Amount paid out under the head of Farm Products.
Amesbury and Salisbury, . .	$85 00	$60 00	-	-	$8 50	$15 00	$8 50	$24 50	$29 75	$85 00	$64 25	$63 75	$11 50	$4 50	$142 50
Barnstable, . .	140 00	48 25	$137 00	$73 00	105 25	376 00	315 25	22 75	68 50	117 00	87 25	95 55	24 00	28 00	238 80
Berkshire, . .	239 00	239 00	609 00	254 00	336 00	1,391 00	1,149 50	201 00	122 00	365 00	323 00	126 00	47 00	50 00	546 00
Bristol, . . .	215 40	152 50	729 00	152 00	231 00	1,550 00	1,012 00	42 00	142 50	275 00	185 50	231 25	45 00	21 50	483 25
Blackstone Valley,	-	-	106 50	58 50	36 50	233 75	201 50	9 00	15 00	23 75	34 25	41 50	5 00	9 50	80 50
Deerfield Valley, .	-	-	189 00	145 00	166 50	550 00	500 50	8 35	7 25	25 00	20 50	48 75	15 00	17 75	135 10
Essex, . . .	275 00	122 00	192 00	276 00	149 00	928 00	473 00	49 00	103 50	445 00	201 00	350 75	39 00	22 50	570 00
Franklin, . .	-	-	100 00	110 00	261 66	615 00	515 66	14 00	39 00	77 00	50 00	112 25	13 00	22 25	204 50
Hampden, . .	484 00	21 00	142 00	97 00	68 00	1,001 50	262 50	21 50	49 25	99 75	62 00	102 00	8 00	19 25	252 15
Hampden East, .	98 00	-	159 00	133 00	64 50	510 00	359 00	11 00	20 75	37 50	31 75	48 75	6 00	11 00	129 25
Hampshire, . .	-	-	96 00	101 00	159 00	507 00	288 50	11 00	22 00	47 00	42 00	70 00	12 00	16 25	140 12
Hampshire, Franklin, and Hampden, . .	-	-	213 00	151 00	189 50	572 50	470 50	3 00	43 75	161 00	50 25	82 75	25 00	22 00	109 00

Highland, . .	40 00	30 00	131 00	125 00	111 25	552 00	368 25	20 50	15 50	-	36 00	31 00	14 10	7 70	93 30
Hingham, . .	219 75	15 00	147 00	44 00	185 60	834 75	376 60	-	37 65	177 00	37 65	120 65	8 10	15 45	181 85
Hoosac Valley, .	67 00	53 00	164 00	138 00	203 00	796 00	601 00	139 50	90 50	241 00	230 00	97 00	47 00	45 00	419 00
Housatonic, . .	217 00	163 00	464 00	248 00	599 00	2,397 00	2,051 00	261 00	112 50	502 00	470 50	161 00	51 00	65 00	807 50
Hillside, . . .	-	-	123 00	113 00	102 00	362 00	347 00	14 60	14 75	40 00	33 45	35 00	27 00	34 10	120 70
Marshfield, . .	73 00	26 25	199 00	69 50	110 00	482 50	257 00	-	65 00	99 00	-	84 30	15 00	36 00	200 30
Martha's Vineyard,	49 00	15 00	150 25	56 00	118 50	391 00	324 75	59 00	84 69	129 00	84 50	73 55	26 00	25 60	125 15
Middlesex, . .	174 00	18 00	103 00	35 00	136 00	556 00	324 00	2 00	49 00	86 00	52 00	251 00	5 00	36 00	323 00
Middlesex North, .	15 00	7 00	152 00	110 00	80 50	679 00	285 00	38 50	26 00	118 00	64 50	173 25	10 00	35 95	219 20
Middlesex South, .	-	-	123 00	67 00	66 50	548 00	256 50	11 50	27 50	85 00	-	74 35	6 00	25 50	144 85
Nantucket, . .	108 00	-	84 00	47 00	49 00	630 00	180 00	20 00	35 75	225 75	21 75	61 75	14 00	15 50	113 00
Plymouth, . .	206 00	-	398 00	185 00	188 75	997 00	771 75	83 00	102 50	269 00	165 00	176 00	38 00	24 50	424 00
Union, . . .	11 00	2 50	157 75	113 00	159 50	734 00	407 86	21 00	70 50	77 00	62 25	17 75	12 25	8 30	103 10
Worcester, . .	-	-	424 00	106 00	89 50	1,503 00	605 00	40 00	75 00	159 00	148 00	230 00	22 00	12 00	368 00
Worcester North, .	28 00	28 00	146 00	66 00	97 50	465 00	309 50	12 25	76 50	95 50	82 75	116 25	10 50	14 50	284 00
Worcester North-west, . . .	22 00	21 00	348 00	118 00	125 50	890 50	578 83	28 00	16 00	69 00	39 67	45 75	18 00	12 00	112 67
Worcester South, .	100 00	-	507 00	751 00	212 30	1,976 00	1,470 30	15 50	15 00	37 50	30 50	91 65	32 00	32 00	154 15
Worcester West, .	65 00	33 00	358 00	155 00	75 25	683 00	565 13	7 50	17 00	62 00	23 38	31 60	22 00	14 30	88 26
Mass. Horticultural, . . .	560 00	100 00	-	-	-	-	-	54 00	207 00	209 00	-	4,574 00	-	-	-
	$3,490 00	$1,154 50	$6,811 50	$4,097 00	$4,485 06	$23,726 50	$15,627 88	$1,244 95	$1,751 59	$4,438 75	$2,733 65	$7,909 15	$628 95	$703 90	$7,313 20

ANALYSIS OF PREMIUMS AND GRATUITIES AWARDED — *Concluded.*

SOCIETIES.	For Agricultural Implements.	Offered for raising Forest Trees.	For Experiments on Manures.	Amount Awarded for Objects strictly Agricultural not already specified.	Amount awarded and paid out for Trotting Horses.	For Objects not strictly Agricultural: Domestic Manufactures.	Number of Persons who received Premiums and Gratuities.
Amesbury and Salisbury,	$5 00	$10 00	-	-	-	$38 25	146
Barnstable,	-	30 00	-	-	$230 00	99 70	484
Berkshire,	43 00	-	-	$78 00	690 00	481 50	987
Bristol,	152 00	23 00	$60 00	-	1,655 00	603 00	400
Blackstone Valley,	-	-	-	-	-	58 00	188
Deerfield Valley,	-	-	-	4 75	40 00	86 80	450
Essex,	31 00	30 00	25 00	10 00	-	216 50	333
Franklin,	-	10 00	-	-	298 00	107 00	275
Hampden,	31 00	30 00	15 00	5 25	-	48 75	154
Hampden East,	3 00	25 00	-	-	385 00	117 75	160
Hampshire,	-	8 00	-	23 00	193 00	135 10	145
Hampshire, Franklin and Hampden,	10 50	20 00	-	-	375 00	109 50	170
Highland,	1 00	-	-	-	37 00	157 85	211
Hingham,	-	63 75	-	-	-	95 00	302
Hoosac Valley,	35 50	-	10 00	32 75	870 00	230 75	318
Housatonic,	-	-	-	42 00	745 00	392 50	534
Hillside,	12 50	-	-	-	-	78 25	329
Marshfield,	4 00	50 00	-	-	230 00	135 11	460
Martha's Vineyard,	5 00	9 00	10 00	-	-	101 01	207
Middlesex,	3 00	50 00	-	-	-	8 00	144
Middlesex North,	10 00	-	-	-	-	3 90	250
Middlesex South,	10 00	30 00	-	60 50	250 00	50 92	174
Nantucket,	-	21 00	15 00	-	-	177 25	250
Plymouth,	-	60 00	-	-	860 00	250 10	429
Union,	11 00	-	-	8 00	265 00	112 45	201
Worcester,	26 50	11 00	-	-	680 00	-	175
Worcester North,	-	25 00	-	-	275 00	330 76	252
Worester Northwest,	3 00	3 30	-	8 00	530 00	79 66	159
Worcester South,	12 75	35 00	-	-	575 00	163 65	193
Worcester West,	11 00	30 00	10 00	-	480 00	56 00	231
Mass. Horticultural,	-	-	-	-	-	-	180
	$420 75	$600 75	$145 00	$272 25	$9,663 00	$4,525 01	8,891

OFFICERS OF THE AGRICULTURAL SOCIETIES, 1886.

AMESBURY AND SALISBURY.

President — FREDERICK W. SARGENT of Salisbury.
Secretary — JOHN Q. EVANS of Salisbury.

BARNSTABLE.

President — AZARIAH ELDRIDGE of Yarmouthport.
Secretary — FRED C. SWIFT of Yarmouthport.

BERKSHIRE.

President — LYMAN PAYNE of Hinsdale.
Secretary — WM. H. MURRAY of Pittsfield.

BLACKSTONE VALLEY.

President — DANIEL W. TAFT of Uxbridge.
Secretary — CHARLES E. CROCKER of Uxbridge.

BRISTOL.

President — PHILANDER WILLIAMS of Taunton.
Secretary — D. L. MITCHELL of Taunton.

DEERFIELD VALLEY.

President — F. S. RICE of Hoosac Tunnel.
Secretary — M. M. MANTOR of Charlemont.

ESSEX.

President — BENJ. P. WARE of Beach Bluff.
Secretary — DAVID W. LOW of Gloucester.

FRANKLIN.

President — CHAS. E. WILLIAMS of Deerfield.
Secretary — FREDERICK L. GREENE of Greenfield.

HAMPDEN.

President — GEORGE S. TAYLOR of Chicopee Falls.
Secretary — J. N. BAGG of West Springfield.

HAMPDEN EAST.

President — WM. HOLBROOK of Palmer.
Secretary — O. P. ALLEN of Palmer.

HAMPSHIRE.

President — D. A. HORTON of Hadley.
Secretary — FRANK E. PAIGE of Amherst.

HAMPSHIRE, FRANKLIN AND HAMPDEN.

President — LUTHER J. WARNER of Northampton.
Secretary — L. C. FERRY of Northampton.

HIGHLAND.

President — HENRY NOBLE of Pittsfield.
Secretary — JONATHAN McELWAIN of Middlefield.

HILLSIDE.

President — ALVAN BARRUS of Goshen.
Secretary — WM. G. ATKINS of West Cummington.

HINGHAM.

President — EBED L. RIPLEY of Hingham Centre.
Secretary — WM. H. THOMAS of Hingham.

HOOSAC VALLEY.

President — WM. L. BROWN of North Adams.
Secretary — H. CLAY BLISS of North Adams.

HOUSATONIC.

President — CHAS. E. SLATER of Tyringham.
Secretary — HENRY T. ROBBINS of Great Barrington.

MARSHFIELD.

President — WM. B. WRIGHT of Duxbury.
Secretary — FRANCIS COLLAMORE of Pembroke.

MARTHA'S VINEYARD.

President — EVERETT ALLEN DAVIS of Tisbury.
Secretary — B. T. HILLMAN of Chilmark.

MASSACHUSETTS.

President — THOMAS MOTLEY of Jamaica Plain.
Secretary — E. F. BOWDITCH of Framingham.

MASSACHUSETTS HORTICULTURAL SOCIETY.

President — Dr. HENRY P. WALCOTT of Cambridge.
Secretary — ROBERT MANNING of Boston.

MIDDLESEX.

President — JOHN CUMMINGS of Woburn.
Secretary — WM. H. HUNT of Concord.

MIDDLESEX NORTH.

President — A. C. VARNUM of Lowell.
Secretary — E. T. ROWELL of Lowell.

MIDDLESEX SOUTH.

President — S. B. BIRD of Framingham.
Secretary — F. M. ESTY of Framingham.

NANTUCKET.

President — R. E. BURGESS of Nantucket.
Secretary — ALBERT EASTON of Nantucket.

PLYMOUTH.

President — ELBRIDGE CUSHMAN of Lakeville.
Secretary — LAFAYETTE KEITH of Bridgewater.

UNION.

President — CHAS. B. HAYDEN of Blandford.
Secretary — ENOS W. BOISE of Blandford.

WORCESTER.

President — CHAS. B. PRATT of Worcester.
Secretary — GEO. H. ESTABROOK of Worcester.

WORCESTER NORTH.

President — EDWIN A. GOODRICH of Fitchburg.
Secretary — F. A. CURRIER of Fitchburg.

WORCESTER NORTHWEST.

President — I. L. CRAGIN of Athol.
Secretary — J. F. WHITCOMB of Athol.

WORCESTER WEST.

President — CHAS. A. GLEASON of New Braintree.
Secretary — SYLVESTER BOTHWELL of Barre.

WORCESTER SOUTH.

President — WALDO JOHNSON of Webster.
Secretary — C. V. COREY of Sturbridge.

AGRICULTURAL EXHIBITIONS, 1886.

AMESBURY AND SALISBURY at *Newburyport*, October 6 and 7.
BARNSTABLE at *Barnstable*, September 28 and 29.
BERKSHIRE at *Pittsfield*, September 14 and 15.
BLACKSTONE VALLEY at *Uxbridge*, September 28 and 29.
BRISTOL at *Taunton*, October 5 and 6.
DEERFIELD VALLEY at *Charlemont*, September 16 and 17.
ESSEX at *Newburyport*, September 28 and 29.
FRANKLIN at *Greenfield*, September 30 and October 1.
HAMPDEN at *Chicopee*, September 22 and 23.
HAMPDEN EAST at *Palmer*, September 14 and 15.
HAMPSHIRE at *Amherst*, September 23 and 24.
HAMPSHIRE, FRANKLIN AND HAMPDEN at *Northampton*, October 6 and 7.
HIGHLAND at *Middlefield*, September 8 and 9.
HINGHAM at *Hingham*, September 28 and 29.
HOOSAC VALLEY at *North Adams*, September 21, 22 and 23.
HOUSATONIC at *Great Barrington*, September 29 and 30.
HILLSIDE at *Cummington*, September 28 and 29.
MASSACHUSETTS HORTICULTURAL. (No date.)
MARSHFIELD at *Marshfield*, September 15, 16 and 17.
MARTHA'S VINEYARD at *West Tisbury*, October 5 and 6.
MIDDLESEX at *Concord*, September 28 and 29.
MIDDLESEX NORTH at *Lowell*, September 15 and 16.
MIDDLESEX SOUTH at *Framingham*. September 21 and 22.
NANTUCKET at *Nantucket*, September 8 and 9.
PLYMOUTH at *Bridgewater*, September 22 and 23.
UNION at *Blandford*, September 15 and 16.
WORCESTER at *Worcester*, September 23 and 24.
WORCESTER NORTH at *Fitchburg*, September 28 and 29.
WORCESTER NORTHWEST at *Athol*, September 21 and 22.
WORCESTER SOUTH at *Sturbridge*, September 16 and 17.
WORCESTER WEST at *Barre*, September 30 and October 1.

APPENDIX.

THIRTEENTH ANNUAL REPORT

ON

COMMERCIAL FERTILIZERS.

By C. A. Goessmann, *State Inspector.*

Gentlemen: — The trade in commercial fertilizers has been quite active during the past year. More than the usual number of individual brands have been noticed in our markets. This circumstance is mainly due to the fact that some new factories for the manufacture of fertilizers have been established in various parts of the State, for the purpose of turning to account suitable refuse material from various local industries.

The quality of the articles offered for sale have proved, in the majority of cases, quite satisfactory, as far as a reasonable agreement with the guaranty of composition was concerned. Only a few exceptionally low grades of compound fertilizers have been observed. As these articles, however, came fairly within the guaranty of the manufacturer, no farther steps could be taken beyond entering the results of the examination on record. It is in most instances better economy to buy high-grade fertilizers at customary market prices of essential constituents.

The cost of agricultural chemicals and materials for manurial purposes has varied but little, at the opening of the last season (1885), from that ruling at the latter portion of the preceding year, 1884.

The following statement represents quite closely the market quotations sent to farmers' clubs by leading manufacturers and dealers in New York and Boston from February to April, 1885: —

Fine Ground Bone: — 22 to 24 per cent. phosphoric acid; $3\frac{1}{2}$ to $4\frac{1}{2}$ per cent. ammonia. Per lb., 2 cents; per ton, \$35 to \$37.

Bone Black, undissolved: — 30 to 34 per cent. phosphoric acid. Per lb., $1\frac{1}{2}$ cents to $1\frac{3}{8}$ cents; per ton, \$25 to \$27.

Dissolved Bone Black: — 15 to 16 per cent. soluble phosphoric acid. Per lb., $1\frac{1}{2}$ cents to $1\frac{5}{8}$ cents; per ton, \$27.50 to \$30.

Plain Superphosphate: — 12 to 13 per cent. Per ton, \$21.

Muriate of Potash: — 80 to 85 per cent. Per lb., $2\frac{1}{4}$ cents to $2\frac{1}{2}$ cents; per ton, \$40 to \$42.50.

Double Sulphate Potash-magnesia: — 48 to 52 per cent. sulphate of potash; 35 to 40 per cent. sulphate of magnesia; not over $2\frac{1}{2}$ per cent. chlorine. Per lb., 2 cents to $2\frac{1}{4}$ cents; per ton, \$38 to \$40.

Kainit: — 23 to 25 per cent. sulphate of potash. Per lb., $\frac{7}{8}$ cents to 1 cent; per ton, \$12 to \$15.

Krvgit: — 18 to 20 per cent. sulphate of potash; balance sulphate of lime and magnesia. Prices same as Kainit.

Sulphate of Magnesia: — 55 per cent. Per lb., $\frac{8}{10}$ cents; per ton, \$12 to \$14.

Fine Ground Plaster: — 95 to 98 per cent. Per ton, \$7 to \$9.

Sulphate of Ammonia: — 24 to 25 per cent. Per lb., $3\frac{1}{2}$ cents to 4 cents; per ton, \$70 to \$72.50.

Nitrate of Soda: — 95 per cent. nitrogen. Per lb., $2\frac{3}{4}$ cents to $3\frac{1}{4}$ cents; per ton, \$53.50 to \$55.

Dried Blood: — 12 to 14 per cent. ammonia. Per ton, \$37 to \$40.

The commercial valuation of the fertilizers described in this report is based on the trade values obtained by taking the average of the wholesale quotations in New York and Boston during the six months preceding March 1, 1885, and increasing them by 20 per cent. to cover expenses for sales, credits, etc. They were recognized and accepted by the fertilizer inspectors of Massachusetts, Connecticut and New Jersey.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals.

	Cents per Pound.	
	1884.	**1885.**
Nitrogen in Ammonia Salts, ...	22	18
" Nitrates, ...	18	18
" Dried and fine-ground fish, . . .	20	18
Organic Nitrogen in guano and fine-ground blood and meat, ...	18	18
Organic nitrogen in cotton seed, linseed meal and castor pomace, ...	18	18
Organic nitrogen in fine-ground bone, . . .	18	18
Organic nitrogen in fine medium bone, . . .	16	16
Organic nitrogen in medium bone, ...	14	14
Organic nitrogen in coarse medium bone, . .	12	12
Organic nitrogen in coarse bone, horn shavings, hair and fish scraps, ...	10	10
Phosphoric acid soluble in water, ...	10	9
Phosphoric acid soluble in ammonium citrate,* .	9	8
Phosphoric acid insoluble in dry, fine-ground fish, and in fine bone, ...	6	6
Phosphoric acid insoluble in fine medium bone, .	5½	5½
Phosphoric acid insoluble in medium bone, . .	5	5
Phosphoric acid insoluble in coarse medium bone, .	4½	4½
Phosphoric acid insoluble in coarse bone, . .	4	4
Phosphoric acid insoluble in fine-ground rock phosphate, ...	2¼	2
Potash as high-grade sulphate, ...	7¼	7¼
Potash as kainite, ...	4¼	4¼
Potash as muriate, ...	4¼	4¼

*Dissolved from two grams of phosphate, unground, by 100 C. C. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes; commonly called "reverted" or "backgone" phosphoric acid.

The latest quotations of leading manufacturers and dealers in agricultural chemicals and in compound commercial fertilizers show an increase in the cost of nitrogen-containing materials. Phosphoric acid and muriate of potash are offered at practically the same prices as during the past season (1885); whilst sulphate of potassa is sold for less.

The beneficial influence of an intelligent supervision of the trade in commercial fertilizers is, from day to day, becoming more recognized by consumers as well as manufacturers; and the list of States adopting laws for the regulation of the inspection of these articles is steadily increasing. The only point to be regretted in this connection consists in the fact that not two States have followed the same course. The disadvantages arising from this circumstance are so generally felt, that measures for securing a more desirable uniformity deserve a serious consideration.

Canada Ashes.

(Munroe, Judson & Stroup, Oswego, N. Y.)

[I. Collected of Edward Swan, South Deerfield, Mass.]

[II. Collected of Walter Crafts & Son, Whately, Mass.]

	Pounds per Hundred.	
	I.	II.
Moisture at 100° C.,	16.55	11.95
Total phosphoric acid,	2.06	1.77
Calcium oxide,	34 42	39.60
Magnesium oxide,	2.52	2.28
Potassium oxide,	5.36	6 46
Insoluble matter,	24.10	10.12

Canada Ashes.

(Munroe, Judson & Stroup, Oswego, N. Y.)

[I. Collected of Albert Montague, South Deerfield, Mass.]

[II. Collected of E. M. Roache, South Deerfield, Mass.]

	Pounds per Hundred.	
	I.	II.
Moisture at 100° C.,	11.25	13.33
Total phosphoric acid,	1.09	1.28
Calcium oxide,	37.62	39 21
Magnesium oxide,	7.47	5.11
Potassium oxide,	6.36	5.91
Insoluble matter,	6.37	9.36

These ashes sold at 25 cents per bushel, of from 45 to 48 lbs., on board of cars.

Pure Ground Bones.

(Manufactured by C. W. Belknap & Co.; collected of J. & J. A. Rice, Worcester, Mass.)

Guaranteed composition : Bone phosphate, 56 to 80 per cent.; phosphoric acid, 24 to 38 per cent.; nitrogen, 4.41 per cent. (equivalent to ammonia, 5.35 per cent.).

	Per cent.
Moisture at 100° C.,	5.00
Total phosphoric acid,	22.11
Reverted phosphoric acid,	2.67
Insoluble phosphoric acid,	19.44
Nitrogen,	4.52

Valuation per two thousand pounds: —

53.4 pounds of reverted phosphoric acid,	$4 27
388.8 pounds of insoluble phosphoric acid,	15 55
90.4 pounds of nitrogen,	16 27
	$36 09

Adams' Fine Ground Bones.

(Collected of J. B. Raynor & Co., Springfield, Mass.)

Guaranteed composition: Phosphoric acid, 18 to 20 per cent.; nitrogen, 4 to 5 per cent. (equivalent to ammonia, 4½ to 5½ per cent.).

	Per cent.
Moisture at 100° C.,	4.90
Total phosphoric acid,	16.78
Soluble phosphoric acid,	.26
Reverted phosphoric acid,	2.30
Insoluble phosphoric acid,	14.22
Nitrogen,	4.44
Insoluble matter,	3.20

Valuation per two thousand pounds: —

5.2 pounds of soluble phosphoric acid,	$0 47
46. pounds of reverted phosphoric acid,	3 68
284.4 pounds of insoluble phosphoric acid,	12 80
88.8 pounds of nitrogen,	15 98
	$32 93

Bowker's Fine Ground Bone.

(Collected of Foskett & Holbrook, Palmer, Mass.)

Guaranteed composition: Ammonia, 3 to 4 per cent. (equivalent to nitrogen, 2.5 to 3.3 per cent.); phosphoric acid, 20 to 23 per cent.

	Per cent.
Moisture at 100° C.,	10.90
Total phosphoric acid,	20.25
Soluble phosphoric acid,	.23
Reverted phosphoric acid,	2.51
Insoluble phosphoric acid,	17.51
Nitrogen,	3.47
Insoluble matter,	.55

Valuation per two thousand pounds: —

4.6 pounds of soluble phosphoric acid,	$0 42
50.2 pounds of reverted phosphoric acid,	4 02
350.2 pounds of insoluble phosphoric acid,	15 76
69.4 pounds of nitrogen,	12 49
	$32 69

L. B. Darling's Fine Ground Bone.

(Collected of J. H. Fairbanks, Fitchburg, Mass.)

Guaranteed composition: Phosphoric acid, 22 to 25 per cent.; bone phosphate, 52 to 55 per cent.; nitrogen, 3.5 to 4.5 per cent. (equivalent to ammonia, 4 to 5 per cent.).

	Per cent.
Moisture at 100° C.,	5.00
Total phosphoric acid,	26.53
Soluble phosphoric acid,	.41
Reverted phosphoric acid,	8.07
Insoluble phosphoric acid,	17.05
Nitrogen,	4.05

Valuation per two thousand pounds:—

8.2 pounds of soluble phosphoric acid,	$0 74
161.4 pounds of reverted phosphoric acid,	12 91
341. pounds of insoluble phosphoric acid,	15 35
81. pounds of nitrogen,	14 58
	$43 58

Swift Sure Bone Meal.

(M. L. Shoemaker & Co., Philadelphia, Pa.; collected of H. L. Phelps, Southampton, Mass.)

Guaranteed composition: Ammonia, 5 to 6 per cent. (equivalent to nitrogen, 4.1 to 5 per cent.); bone phosphate, 45 to 50 per cent.

	Per cent.
Moisture at 100° C.,	3.60
Total phosphoric acid,	20.66
Reverted phosphoric acid,	2.24
Insoluble phosphoric acid,	18.42
Nitrogen,	6.25
Insoluble matter,	4.00

Valuation per two thousand pounds:—

44.8 pounds of reverted phosphoric acid,	$3 58
368.4 pounds of insoluble phosphoric acid,	16 58
125. pounds of nitrogen,	22 50
	$42 66

Bone Meal.

(H. L. Phelps, Southampton, Mass.; collected of E. T. Sabin, Amherst, Mass.)

	Per cent.
Moisture at 100° C.,	8.90
Total phosphoric acid,	22.64
Nitrogen,	3.01

Valuation per two thousand pounds: —

452.8 pounds of phosphoric acid,	$27 17
60.2 pounds of nitrogen,	10 84
	$38 01

Chittenden's Fish and Potash.

(National Fertilizer Co., Bridgeport, Conn.; collected of Wilder & Puffer, Springfield, Mass.)

Guaranteed composition: Ammonia, 3 to 4 per cent. (equivalent to nitrogen, 2.5 to 3.3 per cent.); phosphoric acid, 8 to 10 per cent.; potassium oxide, 4 to 5 per cent.

	Per cent.
Moisture at 100° C.,	9.43
Total phosphoric acid,	7.33
Soluble phosphoric acid,	2.02
Reverted phosphoric acid,	1.82
Insoluble phosphoric acid,	3.49
Potassium oxide,	5.91
Nitrogen,	3.12
Insoluble matter,	3.18

Valuation per two thousand pounds: —

40.4 pounds of soluble phosphoric acid,	$3 64
36.4 pounds of reverted phosphoric acid,	2 91
69.8 pounds of insoluble phosphoric acid,	2 79
118.2 pounds of potassium oxide,	5 02
62.4 pounds of nitrogen,	11 23
	$25 59

Williams, Clark & Co.'s Fish and Potash.

(Collected of Foskett & Holbrook, Palmer, Mass.)

Guaranteed composition: Ammonia, 4 to 5 per cent. (equivalent to nitrogen, 3.5 to 4 per cent.); phosphoric acid, 3 to 4 per cent.; potassium oxide, 3 to 4 per cent.

	Per cent.
Moisture at 100° C.,	9.63
Total phosphoric acid,	7.51
Soluble phosphoric acid,	.54
Reverted phosphoric acid,	2.91
Insoluble phosphoric acid,	4.06
Nitrogen,	3 00
Potassium oxide,	4.30
Insoluble matter,	.80

Valuation per two thousand pounds: —

10.8 pounds of soluble phosphoric acid,	$0 97
58.2 pounds of reverted phosphoric acid,	4 66
81.2 pounds of insoluble phosphoric acid,	3 25
60. pounds of nitrogen,	10 80
86. pounds of potassium oxide,	3 66
	$23 34

Quinnipiac Co.'s (Cross Brand) Fish and Potash.

(Collected of D. A. Horton, Northampton, Mass.)

Guaranteed composition: Nitrogen, $3\frac{1}{4}$ to $4\frac{1}{4}$ per cent.; soluble and reverted phosphoric acid, 3 to 5 per cent.; total, phosphoric acid, 5 to 7 per cent.; potassium oxide, 3 to 5 per cent. (sulphate).

	Per cent.
Moisture at 100° C.,	26.45
Total phosphoric acid,	4.98
Soluble phosphoric acid,	1.73
Reverted phosphoric acid,	2.93
Insoluble phosphoric acid,	.32
Potassium oxide,	3.28
Nitrogen,	3.63

Valuation per two thousand pounds: —

34.6 pounds of soluble phosphoric acid,	$3 12
58.6 pounds of reverted phosphoric acid,	4 69
6.4 pounds of insoluble phosphoric acid,	26
65.6 pounds of potassium oxide,	4 76
72.6 pounds of nitrogen,	13 07
	$25 90

George W. Miles's Fish and Potash.

(Geo. W. Miles & Co., Milford, Conn.; collected of B. F. Bridges, South Deerfield, Mass.)

Guaranteed composition: Ammonia, 3 to 5 per cent. (equivalent to nitrogen, 2.5 to 4 per cent.); available phosphoric acid, 5 to 8 per cent.; potassium oxide, 3 to 5 per per cent. (sulphate).

	Per cent.
Moisture at 100° C.,	14.45
Total phosphoric acid,	10.09
Soluble phosphoric acid,	5.06
Reverted phosphoric acid,	.96
Insoluble phosphoric acid,	4.07
Potassium oxide,	4.90
Nitrogen,	3.09
Insoluble matter,	4.75

Valuation per two thousand pounds: —

101.2 pounds of soluble phosphoric acid,	$9 11
19.2 pounds of reverted phosphoric acid,	1 54
81.4 pounds of insoluble phosphoric acid,	3 26
98. pounds of potassium oxide,	7 10
61.8 pounds of nitrogen,	11 12
	$32 13

Bowker's Fish and Potash.

(Collected of W. S. Westcott, Amherst, Mass.)

Guaranteed composition: Nitrogen, $2\frac{1}{2}$ to $3\frac{1}{4}$ per cent. (equivalent to ammonia, 3 to 4 per cent.); phosphoric acid, 3 to 4 per cent.; bone phosphate, 18 to 22 per cent.; potassium oxide, 4 to 6 per cent.

	Per cent.
Moisture at 100° C.,	8.30
Total phosphoric acid,	10.38
Soluble phosphoric acid,	3.08
Reverted phosphoric acid,	2.86
Insoluble phosphoric acid,	4.44
Potassium oxide,	4.98
Nitrogen,	2.64

Valuation per two thousand pounds: —

61.6 pounds of soluble phosphoric acid,	$5 54
57.2 pounds of reverted phosphoric acid,	4 58
88.8 pounds of insoluble phosphoric acid,	4 00
99.6 pounds of potassium oxide,	4 23
52.8 pounds of nitrogen,	9 50
	$27 85

Quinnipiac Fish and Potash (Cross Fish.)

(Collected of D. A. Horton, Northampton, Mass.)

Guaranteed composition: Total phosphoric acid, 5 to 7 per cent.; nitrogen 3¼ to 4¼ per cent. (equivalent to ammonia, 4 to 5 per cent.); soluble and reverted phosphoric acid, 3 to 5 per cent.; bone phosphate, 11 to 15 per cent.; potassium oxide, 3 to 5 per cent. (guaranteed sulphate).

	Per cent.
Moisture at 100° C.,	23.58
Total phosphoric acid,	7.70
Soluble phosphoric acid,	.48
Reverted phosphoric acid,	3.56
Insoluble phosphoric acid,	3.66
Potassium oxide,	4.70
Nitrogen,	4.30
Insoluble matter,	1.38

Valuation per two thousand pounds:—

9.6 pounds of soluble phosphoric acid,	$0 86
71.2 pounds of reverted phosphoric acid,	5 70
73.2 pounds of insoluble phosphoric acid,	2 93
94. pounds of potassium oxide,	6 82
86. pounds of nitrogen,	15 48
	$31 79

Bowker's Fish and Potash.

(Collected of S. S. Warner, Northampton, Mass.)

Guaranteed composition: Nitrogen, 2¼ to 3¼ per cent. (equivalent to ammonia, 3 to 4 per cent.); phosphoric acid, 8 to 10 per cent.; bone phosphate, 18 to 22 per cent.; potassium oxide, 4 to 6 per cent.

	Per cent.
Moisture at 100° C.,	7.55
Total phosphoric acid,	10.20
Soluble phosphoric acid,	4.29
Reverted phosphoric acid,	1.69
Insoluble phosphoric acid,	4.22
Potassium oxide,	3.32
Nitrogen,	4.03
Insoluble matter,	5 87

Valuation per two thousand pounds:—

85.8 pounds of soluble phosphoric acid,	$7 72
33.8 pounds of reverted phosphoric acid,	2 70
84.4 pounds of insoluble phosphoric acid,	3 38
66.4 pounds of potassium oxide,	2 82
80.6 pounds of nitrogen,	14 51
	$31 13

Quinnipiac Co.'s (Plain Brand) Fish and Potash.

(Collected of D. A. Horton, Northampton, Mass.)

Guaranteed composition: Nitrogen, 2 to 3 per cent. (equivalent to ammonia, 2½ to 3½ per cent.); soluble and reverted phosphoric acid, 4 to 6 per cent.; total phosphoric acid, 6 to 8 per cent.; potassium oxide, 4 to 6 per cent.

	Per cent.
Moisture at 100° C.,	24.93
Total phosphoric acid,	7.26
Soluble phosphoric acid,	.96
Reverted phosphoric acid,	3.96
Insoluble phosphoric acid,	2.34
Potassium oxide,	4.78
Nitrogen,	2.73
Insoluble matter,	2.65

Valuation per two thousand pounds: —

19.2 pounds of soluble phosphoric acid,	$1 73
79.2 pounds of reverted phosphoric acid,	6 34
46.8 pounds of insoluble phosphoric acid,	1 87
95.6 pounds of potassium oxide,	4 06
54.6 pounds of nitrogen,	9 83
	$23 83

Quinnipiac Co.'s (Cross Brand) Fish and Potash.

(Collected of B. L. Bragg & Co., Springfield, Mass.)

Guaranteed composition: Total phosphoric acid, 5 to 7 per cent.; soluble and reverted phosphoric acid, 3 to 5 per cent.; potassium sulphate, 3 to 5 per cent.; ammonia, 4 to 5 per cent. (equivalent to nitrogen, 3.25 to 4.25 per cent.).

	Per cent.
Moisture at 100° C.,	17.30
Total phosphoric acid,	7.67
Soluble phosphoric acid,	.83
Reverted phosphoric acid,	4.06
Insoluble phosphoric acid,	2.78
Potassium oxide,	4.20
Nitrogen,	4.73
Insoluble matter,	.82

Valuation per two thousand pounds: —

16.6 pounds of soluble phosphoric acid,	$1 49
81.2 pounds of reverted phosphoric acid,	6 50
55.6 pounds of insoluble phosphoric acid,	2 23
84. pounds of potassium oxide,	6 09
94.6 pounds of nitrogen,	17 03
	$33 34

Fish and Potash

(H. L. Phelps, Southampton, Mass.; collected of R. T. Prentiss, Holyoke, Mass.)

Guaranteed composition: Ammonia, 3 to 5 per cent. (equivalent to nitrogen, 2.5 to 4 per cent.); phosphoric acid, 4 to 6 per cent.; potassium oxide, 4 to 6 per cent.

	Per cent.
Moisture at 100° C.,	9.85
Total phosphoric acid,	6.56
Soluble phosphoric acid,	1.28
Reverted phosphoric acid,	2.18
Insoluble phosphoric acid,	3.10
Nitrogen,	4.60
Potassium oxide,	5.30
Insoluble matter,	3.00

Valuation per two thousand pounds: —

25.6 pounds of soluble phosphoric acid,	$2 30
43.6 pounds of reverted phosphoric acid,	3 49
62. pounds of insoluble phosphoric acid,	2 79
92. pounds of nitrogen,	16 56
106. pounds of potassium oxide,	4 51
	$29 65

Church's Fish and Potash.

(Collected of Globe Coal Co., Fall River, Mass.)

Guaranteed composition: Total phosphoric acid, 5 to 6 per cent.; soluble phosphoric acid, 1 to 2 per cent.; reverted phosphoric acid, 1 to 2 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; potassium oxide, 3 to 4 per cent.; nitrogen, 4 to 5 per cent. (equivalent to ammonia, 5 to 6 per cent.).

	Per cent.
Moisture at 100° C.,	29.98
Total phosphoric acid,	5.41
Soluble phosphoric acid,	.96
Reverted phosphoric acid,	3.92
Insoluble phosphoric acid,	.53
Nitrogen,	4.26
Potassium oxide,	4.30
Insoluble matter,	1.48

Valuation per two thousand pounds: —

19.2 pounds of soluble phosphoric acid,	$1 73
78.4 pounds of reverted phosphoric acid,	6 27
10.6 pounds of insoluble phosphoric acid,	48
85.2 pounds of nitrogen,	15 34
86. pounds of potassium oxide,	3 66
	$27 48

Bowker's Pure Dry Ground Fish.

(Collected of S. S. Warner, Northampton, Mass.)

Guaranteed composition: Nitrogen, 8 to 10 per cent. (equivalent to ammonia, 10 to 12 per cent.); phosphoric acid, 7 to 8 per cent.; bone phosphate, 16 to 18 per cent.

	Per cent.
Moisture at 100° C.,	11.90
Total phosphoric acid,	7.84
Soluble phosphoric acid,	.70
Reverted phosphoric acid,	2.63
Insoluble phosphoric acid,	4.51
Nitrogen,	8.05
Insoluble matter,	3.08

Valuation per two thousand pounds: —

14. pounds of soluble phosphoric acid,	$1 26
52.6 pounds of reverted phosphoric acid,	4 21
90.2 pounds of insoluble phosphoric acid,	4 06
161. pounds of nitrogen,	28 98
	$38 51

Quinnipiac Dry Ground Fish.

(Collected of D. A. Horton, Northampton, Mass.)

Guaranteed composition: Nitrogen, 7 to 10 per cent. (equivalent to ammonia, 9 to 11 per cent.); soluble and reverted phosphoric acid, 4 to 6 per cent.; total phosphoric acid, 6 to 8 per cent.

	Per cent.
Moisture at 100° C.,	10.88
Total phosphoric acid,	6.85
Soluble phosphoric acid,	.51
Reverted phosphoric acid,	2.82
Insoluble phosphoric acid,	3.52
Nitrogen,	8.67
Insoluble matter,	2.43

Valuation per two thousand pounds: —

10.2 pounds of soluble phosphoric acid,	$0 92
56.4 pounds of reverted phosphoric acid,	4 51
70.4 pounds of insoluble phosphoric acid,	3 17
173.4 pounds of nitrogen,	31 21
	$39 81

Quinnipiac Co.'s Dry Ground Fish.

(Collected of D. A. Horton, Northampton, Mass.)

Guaranteed composition: Nitrogen 7 to 10 per cent.; soluble and reverted phosphoric acid, 4 to 6 per cent.; total phosphoric acid, 6 to 8 per cent.

	Per cent.
Moisture at 100° C.,	8.20
Total phosphoric acid,	7.14
Soluble phosphoric acid,	.67
Reverted phosphoric acid,	2.70
Insoluble phosphoric acid,	3.77
Nitrogen,	7.96
Insoluble matter,	3.50

Valuation per two thousand pounds: —

13.4 pounds of soluble phosphoric acid,	$1 21
54. pounds of reverted phosphoric acid,	4 32
75.4 pounds of insoluble phosphoric acid,	3 02
159.2 pounds of nitrogen,	28 66
	$37 21

Dow's Ground Bone Fertilizer.

(Dow, Davis & Co., Boston; collected of T. Cushing & Co., Fitchburg, Mass.)

Guaranteed composition: Ammonia, $2\frac{1}{2}$ to 3 per cent. (equivalent to nitrogen, 2 to 2.5 per cent.); phosphoric acid, 18 to 22 per cent.; potassium sulphate, 3 to $3\frac{1}{2}$ per cent.

	Per cent.
Moisture at 100° C.,	7.97
Total phosphoric acid,	17.55
Soluble phosphoric acid,	1.22
Reverted phosphoric acid,	6.94
Insoluble phosphoric acid,	9.39
Nitrogen,	3.04
Potassium oxide,	2.48
Insoluble matter,	4.75

Valuation per two thousand pounds: —

24.4 pounds of soluble phosphoric acid,	$2 20
138.8 pounds of reverted phosphoric acid,	11 11
187.8 pounds of insoluble phosphoric acid,	7 51
60.8 pounds of nitrogen,	10 95
49.6 pounds of potassium oxide,	3 60
	$35 37

Chittenden's Bone Superphosphate.

(National Fertilizer Co., Bridgeport, Conn.; collected of T. Cushing & Co., Fitchburg, Mass.)

Guaranteed composition; Ammonia, 2 to 3 per cent. (equivalent to nitrogen, 1.6 to 2.5 per cent.); soluble and available phosphoric acid, 7 to 9 per cent.; total phosphoric acid, 9 to 11 per cent.; bone phosphate, 20 to 24 per cent.; potassium oxide, 2 to 4 per cent.

	Per cent.
Moisture at 100° C.,	11.45
Total phosphoric acid,	9.29
Soluble phosphoric acid,	6.16
Reverted phosphoric acid,	1.65
Insoluble phosphoric acid,	1.48
Potassium oxide,	3.28
Nitrogen,	2.51
Insoluble matter,	4.50

Valuation per two thousand pounds: —

123 2 pounds of soluble phosphoric acid,	$11 09
33. pounds of reverted phosphoric acid,	2 64
29.6 pounds of insoluble phosphoric acid,	1 18
65.6 pounds of potassium oxide,	2 79
50.2 pounds of nitrogen,	9 04
	$26 74

L. L. Crocker's Hop and Potato Fertilizer.

(Collected of Meriam & Rolph, Fitchburg, Mass.)

Guaranteed composition: Soluble phosphoric acid, 6 to 8 per cent.; precipitated phosphoric acid, 2 to 4 per cent.; bone phosphate, 18 to 26 per cent.; insoluble phosphoric acid, 1 to 2 per cent.; ammonia, 2.5 to 3.5 per cent. (equivalent to nitrogen, 2 to 2.9 per cent.); potassium oxide, 6 to 8 per cent.

	Per cent.
Moisture at 100° C.,	12.10
Total phosphoric acid,	9.05
Soluble phosphoric acid,	5.94
Reverted phosphoric acid,	2.10
Insoluble phosphoric acid,	1.01
Potassium oxide,	5.06
Nitrogen,	2.99

Valuation per two thousand pounds: —

118.8 pounds of soluble phosphoric acid,	$10 69
42. pounds of reverted phosphoric acid,	3 36
20.2 pounds of insoluble phosphoric acid,	81
101.2 pounds of potassium oxide,	4 30
59.8 pounds of nitrogen,	10 76
	$29 92

Prepared Phosphate of Lime.

(United States & Canada Co-operative Fertilizer Co., Boston; sent on by W. B. Howe, Marlborough, Mass.)

Guaranteed composition: Moisture, 12 to 15 per cent.; ammonia, 1½ to 2½ per cent. (equivalent to nitrogen, 1¼ to 2 per cent.); available phosphoric acid, 8 to 11 per cent.; potassium sulphate, 4 to 6 per cent.; insoluble matter, 2 to 6 per cent.

	Per cent.
Moisture at 100° C.,	10.63
Total phosphoric acid,	12 54
Soluble phosphoric acid,	6.32
Reverted phosphoric acid,	2.13
Insoluble phosphoric acid,	4.09
Potassium oxide,	3.20
Nitrogen,	2 05
Insoluble matter,	6 50

Valuation per two thousand pounds: —

126.4 pounds of soluble phosphoric acid,	$11 38
42.6 pounds of reverted phosphoric acid,	3 41
81.8 pounds of insoluble phosphoric acid,	3 27
64 pounds of potassium oxide,	4 64
41. pounds of nitrogen,	7 38
	$30 08

Whittemore Bros.' Complete Manure.

(Collected by Secretary State Board of Agriculture. No guaranty received.)

	Per cent.
Moisture at 100° C.,	21.05
Total phosphoric acid,	12.07
Soluble phosphoric acid,	6.08
Reverted phosphoric acid,	4.31
Insoluble phosphoric acid,	1.68
Potassium oxide,	3 20
Nitrogen,	2 68
Insoluble matter,	3 70

Valuation per two thousand pounds: —

121.6 pounds of soluble phosphoric acid,	$10 94
86.2 pounds of reverted phosphoric acid,	6 90
33.6 pounds of insoluble phosphoric acid,	1 34
53.6 pounds of nitrogen,	9 65
64. pounds of potassium oxide,	2 72
	$31 55

Fertilizer No. 203.

(Dole Fertilizer Co., Boston, Mass.; collected of J. A. Lathrop, Boston, Mass.)

Guaranteed composition: Nitrogen, 3 to 4 per cent. (equivalent to ammonia, 3.5 to 4.5 per cent.); total phosphoric acid, 10 to 12 per cent.; available phosphoric acid, 8 to 10 per cent.; potassium oxide, 3 to 4 per cent.

	Per cent.
Moisture at 100° C.,	11.13
Total phosphoric acid,	10 83
Soluble phosphoric acid,	2.62
Reverted phosphoric acid,	3.08
Insoluble phosphoric acid,	5.13
Nitrogen,	3 27
Potassium oxide,	3 98
Insoluble matter,	8.60

Valuation per two thousand pounds: —

52.4 pounds of soluble phosphoric acid,	$4 72
61.6 pounds of reverted phosphoric acid,	4 93
102.6 pounds of insoluble phosphoric acid,	4 10
65.4 pounds of nitrogen,	11 77
79.6 pounds of potassium oxide,	3 38
	$28 90

Soluble Pacific Guano.

(Pacific Guano Co.; Glidden & Curtis, Boston, Mass.; collected of E. C. Haskell South Deerfield, Mass.)

Guaranteed composition: Moisture, 15 to 18 per cent.; ammonia, 2.5 to 3.5 per cent. (equivalent to nitrogen, 2 to 2.9 per cent.); potassium oxide, 2 to 3.5 per cent.; available phosphoric acid, 8 to 10 per cent.; soluble phosphoric acid, 6.5 to 8 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; total phosphoric acid, 12 to 14 per cent.

	Per cent.
Moisture at 100° C.,	14.03
Total phosphoric acid,	12.03
Soluble phosphoric acid,	6.90
Reverted phosphoric acid,	1.83

	Per cent.
Insoluble phosphoric acid,	3 30
Potassium oxide,	2.04
Nitrogen,	2.17
Insoluble matter,	5.40

Valuation per two thousand pounds: —

138. pounds of soluble phosphoric acid,	$12 42
36.6 pounds of reverted phosphoric acid,	2 93
66. pounds of insoluble phosphoric acid,	2 64
40.8 pounds of potassium oxide,	1 73
43.4 pounds of nitrogen,	7 81
	$27 53

George W. Miles' IXL Ammoniated Bone Superphosphate.

(Collected of B. F. Bridges, South Deerfield, Mass.)

Guaranteed composition: Ammonia, 2½ to 4 per cent. (equivalent to nitrogen, 2 to 3.3 per cent); available phosphoric acid, 8 to 12 per cent.; potassium oxide, 1 to 3 per cent.

	Per cent.
Moisture at 100° C.,	17.70
Total phosphoric acid,	12.14
Soluble phosphoric acid,	6 78
Reverted phosphoric acid,	2.53
Insoluble phosphoric acid,	2.93
Potassium oxide,	1 04
Nitrogen,	2.17
Insoluble matter,	5 70

Valuation per two thousand pounds: —

135.6 pounds of soluble phosphoric acid,	$12 20
50.6 pounds of reverted phosphoric acid,	4 05
58.6 pounds of insoluble phosphoric acid,	2 34
20.8 pounds of potassium oxide,	88
43.4 pounds of nitrogen,	7 81
	$27 28

Prepared Phosphate of Lime.

(United States & Canada Co-operative Fertilizer Co.; sent on by J. N. Brown, North Brookfield, Mass.)

Guaranteed composition: Moisture, 15 per cent.; nitrogen, 2.18 per cent. (equivalent to ammonia, 2.65 per cent.); total phosphoric acid, 9.25 per cent. (equivalent to bone phosphate of lime, 20.19 per cent.); soluble and reverted

phosphoric acid, 8.85 per cent.; insoluble phosphoric acid, .40 per cent; potassium oxide, 2.10 per cent. (equivalent to potassium sulphate, 3.88 per cent.).

	Per cent.
Moisture at 100° C,	13.00
Total phosphoric acid,	11.02
Soluble phosphoric acid,	5.81
Reverted phosphoric acid,	2 17
Insoluble phosphoric acid,	3.04
Potassium oxide,	5.10
Nitrogen,	2.23
Insoluble matter,	5.00

Valuation per two thousand pounds: —

116.2 pounds of soluble phosphoric acid,	$10 46
43.4 pounds of reverted phosphoric acid,	3 47
60.8 pounds of insoluble phosphoric acid,	2 43
102. pounds of potassium oxide,	7 40
44.6 pounds of nitrogen,	8 03
	$31 79

Geo. W. Miles' IXL Ammoniated Bone Phosphate.

(Geo. W. Miles & Co., Milford, Conn.; collected of W. S. Westcott, Amherst, Mass.)

Guaranteed composition: Available phosphoric acid, 8 to 12 per cent.; ammonia, 2½ to 3 per cent. (equivalent to nitrogen, 2 to 2½ per cent.); potassium oxide, 1 to 3 per cent.

	Per cent.
Moisture at 100° C.,	14.33
Total phosphoric acid,	11.63
Soluble phosphoric acid,	6.59
Reverted phosphoric acid,	2 11
Insoluble phosphoric acid,	2.93
Nitrogen,	2.67
Potassium oxide,	2 90
Insoluble matter,	6.35

Valuation per two thousand pounds: —

131.8 pounds of soluble phosphoric acid,	$11 86
42.2 pounds of reverted phosphoric acid,	3 38
58.6 pounds of insoluble phosphoric acid,	2 34
53.4 pounds of nitrogen,	9 61
58. pounds of potassium oxide,	2 47
	$29 66

United States Phosphate.

(Lister Brothers; collected of W. S. Westcott, Amherst, Mass.)

Guaranteed composition: Ammonia, 1 to 2 per cent. (equivalent to nitrogen, .82 to 1.65 per cent.); available phosphoric acid, 5.6 to 7 per cent.; insoluble phosphoric acid, 1 to 1½ per cent.; potassium oxide, 2 to 2½ per cent.

	Per cent.
Moisture at 100° C.,	14.55
Total phosphoric acid,	7.85
Soluble phosphoric acid,	1.89
Reverted phosphoric acid,	4.32
Insoluble phosphoric acid,	1.65
Nitrogen,	1.82
Potassium oxide,	2.90
Insoluble matter,	1.85

Valuation per two thousand pounds:—

37.8 pounds of soluble phosphoric acid,	$3 40
86.4 pounds of reverted phosphoric acid,	6 91
33. pounds of insoluble phosphoric acid,	1 32
36.4 pounds of nitrogen,	6 55
58. pounds of potassium oxide,	2 47
	$20 65

Darling's Animal Fertilizer.

(Collected of W. S. Westcott, Amherst, Mass.)

Guaranteed composition: Ammonia, 4 to 6 per cent. (equivalent to nitrogen, 3⅓ to 5 per cent.); phosphoric acid, 10 to 12 per cent.; potassium oxide, 4 to 6 per cent.

	Per cent.
Moisture at 100° C.,	14.93
Total phosphoric acid,	10.52
Soluble phosphoric acid,	.20
Reverted phosphoric acid,	4.40
Insoluble phosphoric acid,	5.92
Potassium oxide,	4.91
Nitrogen,	4.36
Insoluble matter,	1.66

Valuation per two thousand pounds:—

4. pounds of soluble phosphoric acid,	$0 36
88. pounds of reverted phosphoric acid,	7 04
118.4 pounds of insoluble phosphoric acid,	4 74
98.2 pounds of potassium oxide,	4 17
87.2 pounds of nitrogen,	15 70
	$32 01

Stockbridge's Manure for Corn.

(Bowker Fertilizer Co., Boston; collected of W. S. Westcott, Amherst, Mass)

Guaranteed composition: Soluble phosphoric acid, 5 to 6 per cent.; available phosphoric acid, 7 to 8 per cent.; ammonia, 5 to 6 per cent. (equivalent to nitrogen, 4 to 5 per cent.); potassium oxide, 5 to 6 per cent.

	Per cent.
Moisture at 100° C.,	10.95
Total phosphoric acid,	10.16
Soluble phosphoric acid,	6.14
Reverted phosphoric acid,	1.50
Insoluble phosphoric acid,	2.52
Nitrogen,	4.23
Potassium oxide,	4.94
Insoluble matter,	2.89

Valuation per two thousand pounds: —

122.8 pounds of soluble phosphoric acid,	$11 05
30. pounds of reverted phosphoric acid,	2 40
50.4 pounds of insoluble phosphoric acid,	2 02
84.6 pounds of nitrogen,	15 23
98.8 pounds of potassium oxide,	4 20
	$34 90

Bradley's XL Superphosphate.

(Collected of W. S. Westcott, Amherst, Mass.)

Guaranteed composition: Nitrogen, 2.5 to 3.25 per cent. (equivalent to ammonia, 3 to 4 per cent.); soluble phosphoric acid, 7 to 8 per cent.; reverted phosphoric acid, 2 to 3 per cent.; available phosphoric acid, 9 to 11 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; potassium oxide, 2 to 3 per cent. (equivalent to potassium sulphate, 3.7 to 5.55 per cent.).

	Per cent.
Moisture at 100° C.,	13.53
Total phosphoric acid,	12.22
Soluble phosphoric acid,	8.64
Reverted phosphoric acid,	1.91
Insoluble phosphoric acid,	1.67
Nitrogen,	3.35
Potassium oxide,	2.46
Insoluble matter,	5.30

Valuation per two thousand pounds: —

172.8 pounds of soluble phosphoric acid,	$15 55
38.2 pounds of reverted phosphoric acid,	3 06
33.4 pounds of insoluble phosphoric acid,	1 34
67. pounds of nitrogen,	12 06
49.2 pounds of potassium oxide,	3 57
	$35 58

Fertilizer No. 203.

(Dole Fertilizer Co., Boston, Mass.; collected of Frank J. Sherman, Foxborough, Mass.)

Guaranteed composition: Ammonia, 3.5 to 4.5 per cent. (equivalent to nitrogen, 3 to 4 per cent.); total phosphoric acid, 10 to 12 per cent.; available phosphoric acid, 8 to 10 per cent.; potassium oxide, 3 to 4 per cent.

	Per cent.
Moisture at 100° C.,	8.83
Total phosphoric acid,	10.32
Soluble phosphoric acid,	2.81
Reverted phosphoric acid,	2.18
Insoluble phosphoric acid,	5.33
Nitrogen,	3.63
Potassium oxide,	4.06
Insoluble matter,	5.88

Valuation per two thousand pounds: —

56.2 pounds of soluble phosphoric acid,	$5 06
43.6 pounds of reverted phosphoric acid,	3 49
106.6 pounds of insoluble phosphoric acid,	4 26
72.6 pounds of nitrogen,	13 07
81.2 pounds of potassium oxide,	3 45
	$29 33

Bay State Bone Superphosphate.

(J. J. Tucker, Boston; collected of John S. Clark & Son, Worcester, Mass.)

Guaranteed composition: Soluble phosphoric acid, 9.20 per cent.; insoluble phosphoric acid, 3 per cent.; nitrogen, 2.71 per cent. (equivalent to ammonia, 3.29 per cent.).

	Per cent.
Moisture at 100° C.,	22.43
Total phosphoric acid,	10.24
Soluble phosphoric acid,	9.08
Reverted phosphoric acid,	.15
Insoluble phosphoric acid,	1.01
Potassium oxide,	.84
Nitrogen,	2.99
Insoluble matter,	.53

Valuation per two thousand pounds: —

181.6 pounds of soluble phosphoric acid,	$16 34
3. pounds of reverted phosphoric acid,	24
20.2 pounds of insoluble phosphoric acid,	81
16.8 pounds of potassium oxide,	71
59.8 pounds of nitrogen,	10 76
	$28 86

E. Frank Coe's Bone Phosphate of Lime.

(Collected of John S. Clark & Son, Worcester, Mass.)

Guaranteed composition: Soluble and available phosphoric acid, 11.96 per cent.; insoluble phosphoric acid, 1.28 per cent.; nitrogen, 2.64 per cent. (equivalent to ammonia, 3.2 per cent.).

	Per cent.
Moisture at 100° C.,	21.48
Total phosphoric acid,	8.32
Soluble phosphoric acid,	6.78
Reverted phosphoric acid,	.24
Insoluble phosphoric acid,	1.30
Potassium oxide,	.82
Nitrogen,	3.02
Insoluble matter,	.15

Valuation per two thousand pounds: —

135.6 pounds of soluble phosphoric acid,	$12 20
4.8 pounds of reverted phosphoric acid,	38
26. pounds of insoluble phosphoric acid,	1 04
16.4 pounds of potassium oxide,	70
60.4 pounds of nitrogen,	10 87
	$25 19

Darling's Animal Fertilizer.

(Pearse & Esterbrook, Fall River, Mass.)

Guaranteed composition: Ammonia, 4 to 6 per cent. (equivalent to nitrogen, 3⅓ to 5 per cent.); phosphoric acid, 10 to 12 per cent.; potassium oxide, 4 to 6 per cent.

	Per cent.
Moisture at 100° C.,	16.16
Total phosphoric acid,	9.62
Soluble phosphoric acid,	.44
Reverted phosphoric acid,	4.21
Insoluble phosphoric acid,	4.96
Nitrogen,	4.18
Potassium oxide,	5.12
Insoluble matter,	1.38

Valuation per two thousand pounds: —

8.8 pounds of soluble phosphoric acid,	$0 79
84.2 pounds of reverted phosphoric acid,	6 74
99.2 pounds of insoluble phosphoric acid,	3 97
83.6 pounds of nitrogen,	15 05
102.4 pounds of potassium oxide,	4 35
	$30 90

Lowell Bone Fertilizer.

(Collected of Joseph Miller & Co., Lowell, Mass.)

Guaranteed composition: Total phosphoric acid, 10 to 13 per cent.; soluble phosphoric acid, 6 to 10 per cent.; potassium oxide, 4 to 5 per cent.; nitrogen, $2\frac{1}{4}$ to 4 per cent.

	Per cent.
Moisture at 100° C.,	17.48
Total phosphoric acid,	11.29
Soluble phosphoric acid,	9.69
Reverted phosphoric acid,	1.36
Insoluble phosphoric acid,	.24
Nitrogen,	2.63
Potassium oxide,	2.61
Insoluble matter,	.50

Valuation per two thousand pounds: —

193.8 pounds of soluble phosphoric acid,	$17 44
27.2 pounds of reverted phosphoric acid,	2 18
4.8 pounds of insoluble phosphoric acid,	19
52 6 pounds of nitrogen,	9 47
52.2 pounds of potassium oxide,	2 22
	$31 50

Ames' Pure Raw Bone Fertilizer.

(Collected of Chas. P. Preston, Danvers, Mass.)

Guaranteed composition: Ammonia, $2\frac{1}{2}$ to $3\frac{1}{2}$ per cent. (equivalent to nitrogen, 3 to 4 per cent.); available phosphoric acid, 8 to 11 per cent.; potassium chloride, 4 to 6 per cent.

	Per cent.
Moisture at 100° C.,	10.85
Total phosphoric acid,	12.52
Soluble phosphoric acid,	3.58
Reverted phosphoric acid,	7.24
Insoluble phosphoric acid,	1.70
Nitrogen,	3.00
Potassium oxide,	5.88
Insoluble matter,	.78

Valuation per two thousand pounds: —

71.6 pounds of soluble phosphoric acid,	$6 44
144.8 pounds of reverted phosphoric acid,	11 58
34. pounds of insoluble phosphoric acid,	1 36
60. pounds of nitrogen,	10 80
117.6 pounds of potassium oxide,	5 00
	$35 18

L. L. Crocker's Ammoniated Bone Superphosphate.

(Collected of C. W Sears, Worcester, Mass.)

Guaranteed composition: Soluble phosphoric acid, 6 to 8 per cent.; precipitated phosphoric acid, 2 to 4 per cent.; insoluble phosphoric acid, 1 to 2 per cent.; ammonia, 3½ to 4½ per cent. (equivalent to nitrogen, 3 to 3.7 per cent.); potassium oxide, 1 to 3 per cent.

	Per cent.
Moisture at 100° C.,	11.55
Total phosphoric acid,	10 37
Soluble phosphoric acid,	6.30
Reverted phosphoric acid,	2.55
Insoluble phosphoric acid,	1.52
Potassium oxide,	1.42
Nitrogen,	3 37

Valuation per two thousand pounds: —

126. pounds of soluble phosphoric acid,	$11 34
51. pounds of reverted phosphoric acid,	4 08
30.4 pounds of insoluble phosphoric acid,	1 22
28.4 pounds of potassium oxide,	1 21
67.4 pounds of nitrogen,	12 13
	$29 98

Bradley's Original Coe.

(Collected of D. J. Wright, Northampton, Mass.)

Guaranteed composition: Nitrogen, 2.05 to 2.85 per cent. (equivalent to ammonia, 2.5 to 3.5 per cent.); soluble phosphoric acid, 7 to 8 per cent.; reverted phosphoric acid, 2 to 3 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; total phosphoric acid, 11 to 14 per cent.

	Per cent.
Moisture at 100° C.,	12.95
Total phosphoric acid,	12.54
Soluble phosphoric acid,	8.23
Reverted phosphoric acid,	1.90
Insoluble phosphoric acid,	2.41
Potassium oxide,	.30
Nitrogen,	3.07
Insoluble matter,	6.08

Valuation per two thousand pounds : —

164.6 pounds of soluble phosphoric acid, ...	$14 82
38. pounds of reverted phosphoric acid, ...	3 04
48.2 pounds of insoluble phosphoric acid, ...	1 93
6. pounds of potassium oxide, ...	25
61.4 pounds of nitrogen, ...	11 05
	$31 09

Quinnipiac Co.'s Phosphate.

(Collected of D. A. Horton, Northampton, Mass.)

Guaranteed composition : Nitrogen, $2\frac{1}{2}$ to $3\frac{1}{2}$ per cent. ; soluble and reverted phosphoric acid, 8 to 10 per cent. ; insoluble phosphoric acid, 1 to 3 per cent. ; potassium oxide, 2 to 3 per cent.

	Per cent.
Moisture at 100° C., ...	17.60
Total phosphoric acid, ...	12.13
Soluble phosphoric acid, ...	8.06
Reverted phosphoric acid, ...	2.18
Insoluble phosphoric acid, ...	1.89
Nitrogen, ...	3.16
Potassium oxide, ...	2.07
Insoluble matter, ...	4.23

Valuation per two thousand pounds : —

161.2 pounds of soluble phosphoric acid, ...	$14 51
43.6 pounds of reverted phosphoric acid, ...	3 49
37.8 pounds of insoluble phosphoric acid, ...	1 51
63.2 pounds of nitrogen, ...	11 38
41.4 pounds of potassium oxide, ...	1 76
	$32 65

Bradley's XL Ammoniated Bone Superphosphate.

(Collected of D. J. Wright, Northampton, Mass.)

Guaranteed composition : Nitrogen 2.5 to 3.25 per cent. (equivalent to ammonia, 3 to 4 per cent.) ; soluble phosphoric acid, 7 to 8 per cent. ; reverted phosphoric acid, 2 to 3 per cent. ; insoluble phosphoric acid, 2 to 3 per cent. ; total phosphoric acid, 11 to 14 per cent. ; potassium oxide, 2 to 3 per cent. (equivalent to potassium sulphate, 3.7 to 5.55 per cent.).

	Per cent.
Moisture at 100° C.,	14.82
Total phosphoric acid,	12.55
Soluble phosphoric acid,	8.32
Reverted phosphoric acid,	2.59
Insoluble phosphoric acid,	1.64
Potassium oxide,	1.85
Nitrogen,	3.43
Insoluble matter,	4.23

Valuation per two thousand pounds: —

166.4 pounds of soluble phosphoric acid,	$14 98
51.8 pounds of reverted phosphoric acid,	4 15
32.8 pounds of insoluble phosphoric acid,	1 32
37. pounds of potassium oxide,	2 68
68.6 pounds of nitrogen,	12 35
	$35 48

Mitchell's Standard Superphosphate.

(Collected of J. & J. A. Rice, Worcester, Mass.)

Guaranteed composition: Ammonia, 2 to 3 per cent. (equivalent to nitrogen, 1.65 to 2.5 per cent.); soluble phosphoric acid, 8 to 10 per cent.; insoluble phosphoric acid, 2 to 4 per cent.; potassium oxide, 3 to 4 per cent.

	Per cent.
Moisture at 100° C.,	15.53
Total phosphoric acid,	10.98
Soluble phosphoric acid,	6.33
Reverted phosphoric acid,	3.30
Insoluble phosphoric acid,	1.35
Potassium oxide,	3.84
Nitrogen,	1.43
Insoluble matter,	6.10

Valuation per two thousand pounds: —

126.6 pounds of soluble phosphoric acid,	$11 40
66. pounds of reverted phosphoric acid,	5 28
27. pounds of insoluble phosphoric acid,	1 08
76 8 pounds of potassium oxide,	3 26
28.6 pounds of nitrogen,	5 15
	$26 17

Bowker's Hill and Drill Phosphate.

(Collected of J. & J. A. Rice, Worcester, Mass.)

Guaranteed composition: Nitrogen, $2\frac{1}{2}$ to $3\frac{1}{4}$ per cent. (equivalent to ammonia, 3 to 4 per cent.); soluble phosphoric acid, 8 to 10 per cent.; reverted phosphoric acid, 1 to 2 per cent.; total phosphoric acid, 11 to 13 per cent.; potassium sulphate, 2 to 3 per cent.

	Per cent.
Moisture at 100° C.,	16.28
Total phosphoric acid,	12.34
Soluble phosphoric acid,	7.90
Reverted phosphoric acid,	2.63
Insoluble phosphoric acid,	1.81
Potassium oxide,	1.41
Nitrogen,	2.77

Valuation per two thousand pounds: —

158. pounds of soluble phosphoric acid,	$14 22
52.6 pounds of reverted phosphoric acid,	4 21
36.2 pounds of insoluble phosphoric acid,	1 45
28.2 pounds of potassium oxide,	2 05
55.4 pounds of nitrogen,	9 97
	$31 90

Bradley's XL Ammoniated Bone Superphosphate.

(Collected of J. & J. A. Rice, Worcester, Mass.)

Guaranteed composition: Nitrogen, $2\frac{1}{2}$ to $3\frac{1}{4}$ per cent. (equivalent to ammonia, 3 to 4 per cent.); soluble phosphoric acid, 7 to 8 per cent.; reverted phosphoric acid, 2 to 3 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; total phosphoric acid, 11 to 14 per cent.; potassium oxide, 2 to 3 per cent. (equivalent to potassium sulphate, 3.7 to 5.55 per cent.).

	Per cent.
Moisture at 100° C.,	12.30
Total phosphoric acid,	13.12
Soluble phosphoric acid,	7.80
Reverted phosphoric acid,	2.12
Insoluble phosphoric acid,	3.20
Nitrogen,	3.23
Potassium oxide,	1.76
Insoluble matter,	5.28

Valuation per two thousand pounds: —

156. pounds of soluble phosphoric acid,	$14 04
42.4 pounds of reverted phosphoric acid,	3 39
64. pounds of insoluble phosphoric acid,	2 56
64.6 pounds of nitrogen,	11 63
35.2 pounds of potassium oxide,	2 55
	$34 17

Mapes's Potato Fertilizer.

(Collected of W. H. Earle & Co., Worcester, Mass.)

Guaranteed composition: Ammonia (ready formed), soluble nitrogen, etc., 4.5 to 5 per cent.; soluble and available phosphoric acid, 8 to 10 per cent.; potassium oxide (as high grade sulphate and chloride of potash), 6 to 8 per cent.

	Per cent.
Moisture at 100° C.,	12.38
Total phosphoric acid,	12.05
Soluble phosphoric acid,	5.05
Reverted phosphoric acid,	3.24
Insoluble phosphoric acid,	3.76
Total nitrogen,	3.63
Nitrogen (in organic matter),	2.13
Nitrogen (in ammonia salts),	.28
Nitrogen (in nitrates),	1.22
Potassium oxide,	7.62

Valuation per two thousand pounds: —

101. pounds of soluble phosphoric acid,	$9 09
64.8 pounds of reverted phosphoric acid,	5 19
75.2 pounds of insoluble phosphoric acid,	3 01
42.6 pounds of nitrogen (in organic matter),	7 67
5.6 pounds of nitrogen (in ammonia salts),	1 01
24.4 pounds of nitrogen (in nitrates),	4 40
152.4 pounds of potassium oxide,	8 77
	$39 14

Mapes's Complete Manure.

(Collected of W. H. Earle & Co., Worcester, Mass.)

Guaranteed composition: Ammonia, 6 to 7 per cent. (equivalent to nitrogen, 4.9 to 5.8 per cent.); phosphoric acid, 10 to 12 per cent.; potassium oxide, 3 to 4 per cent.

	Per cent.
Moisture at 100° C.,	16.00
Total phosphoric acid,	14.40
Soluble phosphoric acid,	1.63
Reverted phosphoric acid,	7.89
Insoluble phosphoric acid,	4 88
Potassium oxide,	3.54
Nitrogen,	4.58
Insoluble matter,	1.20

Valuation per two thousand pounds: —

32.6 pounds of soluble phosphoric acid,	$2 94
157.8 pounds of reverted phosphoric acid,	12 63
97.6 pounds of insoluble phosphoric acid,	3 91
70.8 pounds of potassium oxide,	3 02
91.6 pounds of nitrogen,	16 49
	$38 99

Bosworth Brothers' Superphosphate of Lime.

(Collected of Wilson & Holden, Worcester, Mass.)

Guaranteed composition: Nitrogen, 2 to 2½ per cent.; soluble phosphoric acid, 7 to 8 per cent.; reverted phosphoric acid, 4 to 5 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; potassium oxide, 2 to 3 per cent.

	Per cent.
Moisture at 100° C.,	10.48
Total phosphoric acid,	15.86
Soluble phosphoric acid,	4.54
Reverted phosphoric acid,	5.38
Insoluble phosphoric acid,	5.94
Potassium oxide,	2.45
Nitrogen,	2.13
Insoluble matter,	1.33

Valuation per two thousand pounds: —

90.4 pounds of soluble phosphoric acid,	$8 17
107.6 pounds of reverted phosphoric acid,	8 61
118.8 pounds of insoluble phosphoric acid,	4 75
49. pounds of potassium oxide,	2 08
42.6 pounds of nitrogen,	7 67
	$31 28

Williams, Clark & Co.'s Ammoniated Bone Superphosphate.

(Collected of B. L. Bragg & Co., Springfield, Mass.)

Guaranteed composition: Ammonia, 2 to 3 per cent. (equivalent to nitrogen, 1.65 to 2.5 per cent.); soluble phosphoric acid, 6 to 8 per cent.; reverted phosphoric acid, 3 to 4 per cent.; insoluble phosphoric acid, 1 to 3 per cent.; total phosphoric acid, 10 to 13 per cent.; potassium sulphate, 4 to 6 per cent. (equivalent to potassium oxide, 2 to 3 per cent.).

	Per cent.
Moisture at 100° C.,	13.03
Total phosphoric acid,	12.63
Soluble phosphoric acid,	9.76
Reverted phosphoric acid,	1.86
Insoluble phosphoric acid,	1.01
Nitrogen,	3.04
Potassium oxide,	2.51
Insoluble matter,	1.20

Valuation per two thousand pounds: —

195.2 pounds of soluble phosphoric acid,	$17 57
37.2 pounds of reverted phosphoric acid,	2 98
20.2 pounds of insoluble phosphoric acid,	81
60.8 pounds of nitrogen,	10 95
50.2 pounds of potassium oxide,	3 63
	$35 94

Baker's A. A. Ammoniated Bone Superphosphate.

(Collected of J. B. Rayner & Co., Springfield, Mass.)

Guaranteed composition: Ammonia, 3 to 4 per cent. (equivalent to nitrogen, 2.5 to 3.3 per cent.); available phosphoric acid, 10 to 12 per cent.; potassium oxide, 2 to 3 per cent.

	Per cent.
Moisture at 100° C.,	9.78
Total phosphoric acid,	11.63
Soluble phosphoric acid,	10.46
Reverted phosphoric acid,	.83
Insoluble phosphoric acid,	.34
Potassium oxide,	2.14
Nitrogen,	3.60
Insoluble matter,	1.25

Valuation per two thousand pounds: —

209.2 pounds of soluble phosphoric acid,	$18 83
16.6 pounds of reverted phosphoric acid,	1 33
6.8 pounds of insoluble phosphoric acid,	27
42.8 pounds of potassium oxide,	1 82
72. pounds of nitrogen,	12 96
	$35 21

The Spear "Perfect Fertilizer."

(Collected of B. Spear & Co., Springfield, Mass.)

Guaranteed composition: Total phosphoric acid, 3.35 per cent.; potassium oxide, .65 per cent.; ammonia, .93 per cent. (equivalent to nitrogen, .77 per cent.).

	Per cent.
Moisture at 100° C.,	20.23
Total phosphoric acid,	7.52
Soluble phosphoric acid,	.32
Reverted phosphoric acid,	6.09
Insoluble phosphoric acid,	1.11
Potassium oxide,	.40
Nitrogen,	.62
Insoluble matter,	33.35

Valuation per two thousand pounds: —

6.4 pounds of soluble phosphoric acid,	$0 58
121.8 pounds of reverted phosphoric acid,	9 75
22.2 pounds of insoluble phosphoric acid,	89
8. pounds of potassium oxide,	34
12.4 pounds of nitrogen,	2 23
	$13 79

H. J. Baker & Bro.'s Complete Manure. (Potato.)

(Collected of J. B. Rayner & Co., Springfield, Mass.)

Guaranteed composition: Ammonia, 4 per cent. (equivalent to nitrogen, 3.3 per cent.); phosphoric acid, $5\frac{3}{4}$ per cent.; potassium oxide, 10 per cent.

	Per cent.
Moisture at 100° C.,	8.75
Total phosphoric acid,	7.60
Soluble phosphoric acid,	6.17
Reverted phosphoric acid,	1.19
Insoluble phosphoric acid,	.24
Potassium oxide,	8.20
Nitrogen,	3.78
Insoluble matter,	.65

Valuation per two thousand pounds: —

123.4 pounds of soluble phosphoric acid,	$11 11
23.8 pounds of reverted phosphoric acid,	1 91
4.8 pounds of insoluble phosphoric acid,	19
164. pounds of potassium oxide,	6 97
75.6 pounds of nitrogen,	13 61
	$33 79

"*Stockbridge's Manures.*" (*Potato.*)

(Bowker Fertilizer Co, Boston, Mass.; collected of Wilder & Puffer, Springfield, Mass.)

Guaranteed composition: Nitrogen, 3.25 to 4.25 per cent. (equivalent to ammonia, 4 to 5 per cent.); soluble and reverted phosphoric acid, 7 to 8 per cent.; total phosphoric acid, 8 to 10 per cent.; potassium oxide, 5 to 6 per cent.

	Per cent.
Moisture at 100° C.,	10.08
Total phosphoric acid,	10.06
Soluble phosphoric acid,	5.76
Reverted phosphoric acid,	2.18
Insoluble phosphoric acid,	2.12
Potassium oxide,	4.56
Nitrogen,	4.66
Insoluble matter,	3.88

Valuation per two thousand pounds: —

115.2 pounds of soluble phosphoric acid,	$10 37
43.6 pounds of reverted phosphoric acid,	3 49
42.4 pounds of insoluble phosphoric acid,	1 70
91.2 pounds of potassium oxide,	3 88
93.2 pounds of nitrogen,	16 78
	$36 22

Adams' "*Market Bone Fertilizer.*"

(Collected of J. B. Rayner & Co., Springfield, Mass.)

Guaranteed composition: Phosphoric acid, 10 to 12 per cent.; soluble and available phosphoric acid, 8 to 10 per cent.; nitrogen, $3\frac{1}{2}$ to $4\frac{1}{2}$ per cent. (equivalent to ammonia, $4\frac{1}{4}$ to $5\frac{1}{4}$ per cent.); potassium oxide, 3 to 4 per cent.

	Per cent.
Moisture at 100° C.,	6.55
Total phosphoric acid,	10.68
Soluble phosphoric acid,	3.39
Reverted phosphoric acid,	2.74
Insoluble phosphoric acid,	4.55
Potassium oxide,	3.12
Nitrogen,	4.13

Valuation per two thousand pounds: —

67.8 pounds of soluble phosphoric acid,	$6 10
54.8 pounds of reverted phosphoric acid,	4 39
91. pounds of insoluble phosphoric acid,	3 64
62.4 pounds of potassium oxide,	2 65
82.6 pounds of nitrogen,	14 87
	$31 65

Lister Brothers' Ammoniated Bone Superphosphate.

(Collected of W. S. Westcott, Amherst, Mass.)

Guaranteed composition: Moisture, 10 to 14 per cent.; available and phosphoric acid, 8 to 10 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; potassium oxide, 1½ to 2 per cent.; nitrogen, 1.6 to 2 per cent.

	Per cent.
Moisture at 100° C.,	11.75
Total phosphoric acid,	11.65
Soluble phosphoric acid,	6.97
Reverted phosphoric acid,	1.83
Insoluble phosphoric acid,	2.85
Nitrogen,	2.64
Potassium oxide,	1.54
Insoluble matter,	1.60

Valuation per two thousand pounds: —

139.4 pounds of soluble phosphoric acid,	$12 55
36.6 pounds of reverted phosphoric acid,	2 93
57. pounds of insoluble phosphoric acid,	2 28
52.8 pounds of nitrogen,	9 51
30.8 pounds of potassium oxide,	1 31
	$28 58

Chittenden's Complete Tobacco Fertilizer.

(National Fertilizer Co., Bridgeport, Conn.; collected of Slate & DeWolf, Greenfield, Mass.)

Guaranteed composition: Ammonia, 4 to 6 per cent. (equivalent to nitrogen, 3.3 to 5 per cent.); total phosphoric acid, 8 to 10 per cent.; soluble and available phosphoric acid, 6 to 8 per cent.; bone phosphate, 18 to 22 per cent.; potassium sulphate, 8 to 10 per cent.

	Per cent.
Moisture at 100° C.,	14.88
Total phosphoric acid,	7.37
Soluble phosphoric acid,	5.76
Reverted phosphoric acid,	.92
Insoluble phosphoric acid,	.69
Nitrogen,	3.53
Potassium oxide,	7.32
Insoluble matter,	1.93

Valuation per two thousand pounds: —

115.2 pounds of soluble phosphoric acid,	$10 37
18.4 pounds of reverted phosphoric acid,	1 47
13.8 pounds of insoluble phosphoric acid,	55
70.6 pounds of nitrogen,	12 71
146.4 pounds of potassium oxide,	10 62
	$35 72

Williams, Clark & Co.'s "Americus" Ammoniated Superphosphate.

(Collected of Slate & DeWolf, Greenfield, Mass.)

Guaranteed composition: Ammonia, 2 to 3 per cent. (equivalent to nitrogen, 1.65 to 2.6 per cent.); soluble phosphoric acid, 6 to 8 per cent.; reverted phosphoric acid, 3 to 4 per cent.; insoluble phosphoric acid, 1 to 3 per cent.; total phosphoric acid, 10 to 13 per cent; potassium sulphate, 4 to 6 per cent.; potassium oxide, 2 to 3 per cent.; magnesium sulphate, 3 to 4 per cent.

	Per cent.
Moisture at 100° C.,	13.03
Total phosphoric acid,	11.80
Soluble phosphoric acid,	9.40
Reverted phosphoric acid,	1.34
Insoluble phosphoric acid,	1.06
Nitrogen,	3.56
Potassium oxide,	2.86
Insoluble matter,	.85

Valuation per two thousand pounds: —

188. pounds of soluble phosphoric acid,	$16 92
26.8 pounds of reverted phosphoric acid,	2 11
21.2 pounds of insoluble phosphoric acid,	85
71.2 pounds of nitrogen,	12 82
57.2 pounds of potassium oxide,	4 15
	$36 88

Crocker's Ammoniated Bone Superphosphate.

(Collected of Slate & DeWolf, Greenfield, Mass.)

Guaranteed composition: Soluble phosphoric acid, 6 to 8 per cent.; precipitated phosphoric acid, 2 to 4 per cent.; insoluble phosphoric acid, 1 to 2 per cent.; bone phosphate, 18 to 26 per cent.; ammonia, 3.5 to 4.5 per cent.); (equivalent to nitrogen, 2.9 to 3.8 per cent.); potassium sulphate, 1 to 3 per cent.

	Per cent.
Moisture at 100° C.,	14.48
Total phosphoric acid,	9.43
Soluble phosphoric acid,	7.29
Reverted phosphoric acid,	1.14
Insoluble phosphoric acid,	1.00
Nitrogen,	3.07
Potassium oxide,	1.60

Valuation per two thousand pounds: —

145.8 pounds of soluble phosphoric acid,	$13 12
22.8 pounds of reverted phosphoric acid,	1 82
20. pounds of insoluble phosphoric acid,	80
61.4 pounds of nitrogen,	11 05
32. pounds of potassium oxide,	2 32
	$29 11

Chittenden's Universal Phosphate.

(Collected of Slate & DeWolf, Greenfield, Mass.)

Guaranteed composition: Ammonia, 2½ to 3½ per cent. (equivalent to nitrogen, 2 to 2.9 per cent.); soluble and available phosphoric acid, 8 to 10 per cent.; total phosphoric acid, 10 to 12 per cent.; bone phosphate, 22 to 26 per cent.; potassium oxide, 2 to 4 per cent.

	Per cent.
Moisture at 100° C.,	14.48
Total phosphoric acid,	9.43
Soluble phosphoric acid,	7.29
Reverted phosphoric acid,	1.14
Insoluble phosphoric acid,	1.00
Nitrogen,	3.07
Potassium oxide,	2.50
Insoluble matter,	4.60

Valuation per two thousand pounds: —

145.8 pounds of soluble phosphoric acid,	$13 12
22.8 pounds of reverted phosphoric acid,	1 83
20. pounds of insoluble phosphoric acid,	80
61.4 pounds of nitrogen,	11 05
50. pounds of potassium oxide,	2 13
	$28 93

Bradley's XL Superphosphate of Lime.

(Collected of Garfield & Procter, Fitchburg, Mass.)

Guaranteed composition: Nitrogen, $2\frac{1}{2}$ to $3\frac{1}{4}$ per cent. (equivalent to ammonia, 3 to 4 per cent.); soluble phosphoric acid, 7 to 8 per cent.; reverted phosphoric acid, 2 to 3 per cent.; available phosphoric acid, 9 to 11 per cent.; total phosphoric acid, 11 to 14 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; potassium oxide, 2 to 3 per cent.; potassium sulphate, 3.7 to 5.55 per cent.

	Per cent.
Moisture at 100° C.,	11 00
Total phosphoric acid,	11.42
Soluble phosphoric acid,	8.22
Reverted phosphoric acid,	1.05
Insoluble phosphoric acid,	2.15
Potassium oxide,	3.41
Nitrogen,	3.05

Valuation per two thousand pounds: —

164.4 pounds of soluble phosphoric acid,	$14 80
21. pounds of reverted phosphoric acid,	1 68
43. pounds of insoluble phosphoric acid,	1 72
68.2 pounds of potassium oxide,	4 95
61. pounds of nitrogen,	10 98
	$34 13

L. L. Crocker's Ammoniated Bone Superphosphate.

(Collected of H. C. Kingman, South Framingham, Mass.)

Guaranteed composition: Soluble phosphoric acid, 6 to 8 per cent.; precipitated phosphoric acid, 2 to 4 per cent.; insoluble phosphoric acid, 1 to 2 per cent.; bone phosphate, 18 to 26 per cent.; ammonia, $3\frac{1}{2}$ to $4\frac{1}{2}$ per cent. (equivalent to nitrogen, 2.9 to 3.7 per cent.); potassium sulphate, 1 to 3 per cent.

	Per cent.
Moisture at 100° C.,	11.00
Total phosphoric acid,	11.93
Soluble phosphoric acid,	7.13
Reverted phosphoric acid,	2.36
Insoluble phosphoric acid,	2.44
Potassium oxide,	1.70
Nitrogen,	4.39
Insoluble matter,	4.30

Valuation per two thousand pounds: —

142.6 pounds of soluble phosphoric acid,	$12 83
47.2 pounds of reverted phosphoric acid,	3 78
48.8 pounds of insoluble phosphoric acid,	1 95
87.8 pounds of nitrogen,	15 80
34. pounds of potassium oxide,	2 47
	$36 83

Bowker's Hill and Drill Phosphate.

(Collected of Sprague & Williams, South Framingham, Mass.)

Guaranteed composition: Nitrogen, 2½ to 3¼ per cent. (equivalent to ammonia, 3 to 4 per cent.); soluble phosphoric acid, 8 to 10 per cent.; reverted phosphoric acid, 1 to 2 per cent.; total phosphoric acid, 11 to 13 per cent.; potassium sulphate, 2 to 3 per cent.

	Per cent.
Moisture at 100° C.,	13.45
Total phosphoric acid,	10.85
Soluble phosphoric acid,	6.51
Reverted phosphoric acid,	2.01
Insoluble phosphoric acid,	2.33
Potassium oxide,	2.81
Nitrogen,	3.45

Valuation per two thousand pounds: —

130.2 pounds of soluble phosphoric acid,	$11 72
40.2 pounds of reverted phosphoric acid,	3 22
46.6 pounds of insoluble phosphoric acid,	1 86
56.2 pounds of potassium oxide,	4 08
69. pounds of nitrogen,	12 42
	$33 30

Davidge's A. A. Ammoniated Bone Superphosphate.

(Russell Coe's Co., New York; collected of A. B. Lawrence & Co., Fitchburg, Mass.)

Guaranteed composition: Moisture, 10 to 15 per cent.; ammonia, 2 to 3 per cent. (equivalent to nitrogen, 1.65 to 2.5 per cent.); soluble and available phosphoric acid, 9 to

11 per cent. ; insoluble phosphoric acid, 1 to 2 per cent. ; total phosphoric acid, 10 to 12 per cent. ; potassium oxide, 1½ to 2½ per cent.

	Per cent.
Moisture at 100° C.,	15.05
Total phosphoric acid,	11.31
Soluble phosphoric acid,	4.86
Reverted phosphoric acid,	1.78
Insoluble phosphoric acid,	4.68
Nitrogen,	2.28
Potassium oxide,	1.66

Valuation per two thousand pounds : —

97.2 pounds of soluble phosphoric acid,	$8 75
35.6 pounds of reverted phosphoric acid,	2 85
93.6 pounds of insoluble phosphoric acid,	3 75
45.6 pounds of nitrogen,	8 21
33.2 pounds of potassium oxide,	1 41
	$24 97

Soluble Pacific Guano.

(Pacific Guano Co., Boston; collected of Pearse & Esterbrook, Fall River, Mass.)

Guaranteed composition: Moisture, 15 to 18 per cent. ; total phosphoric acid, 12 to 14 per cent. ; soluble phosphoric acid, 6.5 to 8 per cent. ; reverted phosphoric acid, 1.5 to 3 per cent. ; insoluble phosphoric acid, 2 to 4 per cent. ; nitrogen, 2 to 3 per cent. (equivalent to ammonia, 2½ to 3½ per cent.) ; potassium oxide, 2 to 3½ per cent.

	Per cent.
Moisture at 100° C.,	15 10
Total phosphoric acid,	12.05
Soluble phosphoric acid,	7.36
Reverted phosphoric acid,	2 11
Insoluble phosphoric acid,	2.58
Potassium oxide,	2.58
Nitrogen,	2.67
Insoluble matter,	6.25

Valuation per two thousand pounds : —

147.2 pounds of soluble phosphoric acid,	$13 25
42.2 pounds of reverted phosphoric acid,	3 38
51.6 pounds of insoluble phosphoric acid,	2 06
51.6 pounds of potassium oxide,	2 19
53.4 pounds of nitrogen,	9 61
	$30 49

Standard Superphosphate.

(Collected of C. H. Thompson & Co., South Market Street, Boston, Mass)

Guaranteed composition: Ammonia 3 to 4 per cent. (equivalent to nitrogen, 2.5 to $3\frac{1}{3}$ per cent); available phosphoric acid, 9 to 13 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; potassium oxide, 2 to 4 per cent.

	Per cent.
Moisture at 100° C.,	5.58
Total phosphoric acid,	11.68
Soluble phosphoric acid,	2.62
Reverted phosphoric acid,	5.96
Insoluble phosphoric acid,	3.10
Potassium oxide,	2 41
Nitrogen,	2.80
Insoluble matter,	5.78

Valuation per two thousand pounds: —

52.4 pounds of soluble phosphoric acid,	$4 72
119.2 pounds of reverted phosphoric acid,	9 54
62. pounds of insoluble phosphoric acid,	2 48
48.2 pounds of potassium oxide,	2 05
56. pounds of nitrogen,	10 08
	$28 87

Davidge's Soluble Bone Phosphate.

(Russell Coe Fertilizer Co., New York; collected of Pearse and Esterbrook, Fall River, Mass.)

Guaranteed composition: Moisture 10 to 15 per cent.; soluble and available phosphoric acid, 10 to 12 per cent.; total phosphoric acid, 12 to 14 per cent.; potassium oxide, $1\frac{1}{2}$ to $2\frac{1}{2}$ per cent.

	Per cent.
Moisture at 100° C.,	10.05
Total phosphoric acid,	17.24
Soluble phosphoric acid,	4.80
Reverted phosphoric acid,	6.24
Insoluble phosphoric acid,	6.20
Potassium oxide,	1.58
Nitrogen,	.71
Insoluble matter,	6.55

Valuation per two thousand pounds: —

96. pounds of soluble phosphoric acid,	$8 64
124.8 pounds of reverted phosphoric acid,	9 98
124. pounds of insoluble phosphoric acid,	4 96
31.6 pounds of potassium oxide,	1 34
14.2 pounds of nitrogen,	2 56
	$27 48

Mitchell's Standard Superphosphate.

(Collected of J. & J. A. Rice, Worcester, Mass.)

Guaranteed composition: Ammonia $2\frac{1}{2}$ to 3 per cent. (equivalent to nitrogen 2 to $2\frac{1}{2}$ per cent.); soluble phosphoric acid, 8 to 10 per cent.; insoluble phosphoric acid, 2 to 4 per cent.; potassium oxide, 3 to 4 per cent.

	Per cent.
Moisture at 100° C.,	10.60
Total phosphoric acid,	10.80
Soluble phosphoric acid,	6.30
Reverted phosphoric acid,	2.67
Insoluble phosphoric acid,	1.83
Nitrogen,	3.60
Potassium oxide,	3.30
Insoluble matter,	6.23

Valuation per two thousand pounds: —

126. pounds of soluble phosphoric acid,	$11 34
53.4 pounds of reverted phosphoric acid,	4 27
36.6 pounds of insoluble phosphoric acid,	1 46
72. pounds of nitrogen,	12 96
66. pounds of potassium oxide,	2 81
	$32 84

Darling's Animal Fertilizer.

(Collected of C. H. Thompson, 80 to 82 South Market Street, Boston, Mass.)

Guaranteed composition: Nitrogen, 4 to 6 per cent. (equivalent to ammonia, 6 to 8 per cent.); phosphoric acid, 10 to 12 per cent.; potassium oxide, 5 to 6 per cent.

	Per cent.
Moisture at 100° C.,	9.46
Total phosphoric acid,	15.34
Soluble phosphoric acid,	.45
Reverted phosphoric acid,	5.15
Insoluble phosphoric acid,	9.74
Potassium oxide,	4.10
Nitrogen,	2.80
Insoluble matter,	3.40

Valuation per two thousand pounds: —

9. pounds of soluble phosphoric acid,	$0 81
103. pounds of reverted phosphoric acid,	8 24
194.8 pounds of insoluble phosphoric acid,	7 79
82. pounds of potassium oxide,	3 49
56. pounds of nitrogen,	10 08
	$30 41

M. L. Shoemaker & Co.'s Superphosphate.

(Collected of H. L. Phelps, Northampton, Mass.)

Guaranteed composition: Ammonia, 3 to 5 per cent. (equivalent to nitrogen, 2.5 to 4 per cent.); soluble and reverted phosphoric acid, 9 to 11 per cent.; insoluble phosphoric acid, 5 to 6 per cent.; potassium sulphate, 4 to 6 per cent.

	Per cent.
Moisture at 100° C.,	10.00
Total phosphoric acid,	13.89
Soluble phosphoric acid,	7.07
Reverted phosphoric acid,	2.28
Insoluble phosphoric acid,	4.54
Nitrogen,	3.03
Potassium oxide,	4.48
Insoluble matter,	4.38

Valuation per two thousand pounds:—

141.4 pounds of soluble phosphoric acid,	$12 73
45.6 pounds of reverted phosphoric acid,	3 65
90.8 pounds of insoluble phosphoric acid,	3 63
60.6 pounds of nitrogen,	10 91
89.6 pounds of potassium oxide,	6 50
	$37 42

APPENDIX.

COMPOSITION OF SOME COMPOUNDS IN FERTILIZERS.

One hundred parts of: —

Nitric acid contain 26 parts of nitrogen.

Ammonia contain 82.35 parts of nitrogen.

Pure nitrate of potassa (saltpetre) contain 53.4 parts of nitric acid and 46.6 parts of potassium oxide.

Pure nitrate of soda (Chili saltpetre) contain 63.25 parts of nitric acid.

Chloride of potassium contain 52.4 parts of potassium, 63.1 parts of potassium oxide, and 47.6 parts of chlorine.

Pure sulphate of potassa contain 54.9 parts of potassium oxide and 46 parts of sulphuric acid.

Bone phosphate (tricalcic phosphate) contain 46 parts of phosphoric acid and 54 parts of calcium oxide (lime).

Calcined gypsum contain 41 parts of calcium oxide (lime) and 59 parts of sulphuric acid.

Uncalcined pure gypsum contain 32.5 parts of calcium oxide (lime), 46.5 parts of sulphuric acid, and 21 parts of water.

Carbonate of lime contain 56 parts of calcium oxide (lime) and 44 parts of carbonic acid.

Sulphate of magnesia (free of water) contain 33.3 per cent. of magnesium oxide (magnesia) and 66.6 per cent. of sulphuric acid.

C. A. GOESSMANN.

SOME ADDITIONAL NOTES UPON TREES AND TREE PLANTING IN MASSACHUSETTS.

BY C. S. SARGENT,
DIRECTOR OF THE ARNOLD ARBORETUM OF HARVARD COLLEGE.

The subject of economic tree planting in Massachusetts was discussed by me in two papers * published in the reports of the Massachusetts State Board of Agriculture for 1875 and 1878. Many of the conclusions reached in those papers, however, have not been substantiated by further investigations upon the same subject made during the past ten years. When they were prepared, I, like most American writers upon subjects relating to forestry, was strongly impressed with the value of various foreign trees for general cultivation in this State. I am now as fully convinced that the native trees of Massachusetts are better suited to Massachusetts than any exotic trees can be, and that if our woods and plantations are ever to assume real importance, and to make profitable returns upon the money invested in them, they must be composed either wholly or in large part of our native trees. Some of the most valuable timber trees known to man flourish naturally within the borders of this State, or may be found not far beyond its limits; but this material, placed within easy reach of Massachusetts planters, has been too often neglected, and in some conspicuous cases has been entirely replaced by foreign trees, which, as it is now known, are incapable of flourishing here for any length of time, or of yielding adequate returns for the time and money expended upon their cultivation.

* A Few Suggestions on Tree Planting. Notes on Trees and Tree Planting.

The passion for cultivating exotic trees is not new. The possibility of increasing the productive capacity of a country through the introduction of some foreign tree of first-rate importance has long occupied the attention of the most enlightened rural economists. This desire to increase the value of forests by the introduction into them of the best trees of foreign countries has been a powerful stimulant to botanical and especially to dendrological research; it has vastly increased the interest in horticulture, and extended, sometimes dangerously, it is true, the possibilities of the gardener's art. The purely economic results, however, obtained in northern Europe and in the United States during the last fifty years of great activity and interest in the introduction and cultivation of exotic trees are not encouraging. While Europe been able to enrich and beautify her ornamental plantations from the forests of America, and especially from the great coniferous forests of western North America, and from those of western and southern Asia and the Caucasus, European forests, planted with the object of producing timber only, are still, with a few English exceptions, exclusively composed of half a dozen species of trees, native of central Europe. This is not the result of prejudice nor of ignorance. European foresters have long studied, and are still actively and widely studying, the possibility of profitably introducing on a large scale various foreign trees into their great artificial forests. The results thus far obtained, however, from these investigations show that while a foreign tree may often possess very great value in ornamental plantations, it is the native trees only of a country which can always be safely depended upon in that country to make profitable money returns to the planter.

Europe has done little to beautify the plantations of New England; the Norway maple, the horse chestnut, which must now be considered a European tree, the elm, the beech, the birch, the willow and the larch, none of them, in our climate, equal in mere beauty to their American congeners, with the exception, perhaps, of the willow, are the only European trees which seem capable of reaching any great age or development in this State. Western Asia has given us the ginko, the mulberry and the ailanthus, really

valuable additions to our plantations, besides many other trees, especially conifers, about which it is too soon yet to speak with any degree of certainty, although the similarity between eastern Asiatic and eastern American climates is marked enough to induce the hope that the plants of one of these regions will flourish in the other. If foreign countries have done little for our ornamental plantations, they have done still less for our forests.

There is certainly no proof yet, and perhaps no very strong indication even, that any foreign tree, with the exception only of the willow,* yet introduced into Massachusetts, has qualities not possessed in a greater degree by some native tree, which would recommend its general cultivation in economic forest planting, although it is, of course, too soon yet to pronounce with perfect confidence upon all the foreign trees introduced into our plantations. Individual interest, which has cultivated here foreign trees, and especially European trees, often upon a large scale, has made it possible to determine at least that many trees, largely cultivated in Europe in economic forests, and in America in ornamental plantations, are utterly unsuited to our climate. Too much praise can hardly be given to the men who have been patiently testing here for years the merits of foreign trees, and the recognition of their service to Massachusetts agriculture should be all the more strongly expressed, because, so far as they are concerned individually, such experiments have generally resulted in failure and disappointment.

The facts which have been established and the lessons which may be learned from these arboricultural experiments which have been carried on in Massachusetts during the last seventy-five years with more or less intelligence and persistency are, in regard to certain European trees, briefly these:

The European lindens, of which two or three species are cultivated in Massachusetts, are in every way inferior here, except in perfume of flower, to our native species. They suffer greatly from the attacks of various wood-borers, and usually perish before reaching any great age. The sycamore maple (*Acer pseudo-platanus*), a common European

* A Few Suggestions on Tree Planting, p. 25.

species, largely cultivated there for its valuable timber, and early and quite generally planted in eastern Massachusetts, grows, like many European trees, very rapidly while young, but is soon unsightly here, short lived, and quite worthless for any economic purpose.

The Norway maple (*Acer platanoides*) is a more valuable tree here, although greatly inferior to our native sugar and red maples in beauty and general usefulness. It grows rapidly and vigorously in Massachusetts, especially near the sea, reproducing itself freely, and giving every promise of reaching as great development as in its native land. The fact that its leaves are often covered with thrip and red spiders during the summer months, especially when planted beyond the influences of sea-breezes, is the only drawback yet discovered to the general introduction of this tree into ornamental plantations, and especially sea-coast plantations, in Massachusetts. The European ash (*Fraxinus excelsior*), and its innumerable varieties, once largely and now occasionally planted in Massachusetts, are here short lived, brittle and utterly worthless trees, which should be exterminated in every Massachusetts plantation, to make room for our noble white ash (*Fraxinus Americana*), which nowhere thrives with greater vigor or yields better returns to the planter.

It is too soon, perhaps, to speak with any degree of certainty in regard to the future of the European sycamore (*Platanus orientalis*) in Massachusetts. Young trees, however, forty or fifty years old, grow with a vigor now never attained by our native species, and certainly give promise of long life and full development. Two species of elm (*Ulmus campestris* and *U. montana*), natives of Europe, thrive as well or nearly as well in Massachusetts as any of our native species. Specimens of the former * attain a size in eastern Massachusetts never reached here by any other foreign tree, with the exception, perhaps, of the white willow; while the Dutch elm (*U. montana*), now everywhere, reproduces itself from seed, and will doubtless eventually become completely naturalized in our woods.

The European oak (*Quercus robur*) has always been a

* A Few Suggestions on Tree Planting, p. 24.

favorite tree among Massachusetts planters of a certain class. This tree grows here very rapidly when young; it can be easily raised and very easily transplanted; its habit is excellent, and it carries its green foliage into early winter, long after our native trees have shed their leaves. It is, perhaps, however, the most unsatisfactory deciduous tree which has ever been planted in Massachusetts. The promise of its early life is never realized. The European oak begins to fail in Massachusetts when about twenty years old, with the cracking of the main stem, and then, after dragging out a wretched existence for a few years longer, miserably perishes. Tens of thousands of these trees have been planted in this State during the last century, but it is now almost impossible to find anywhere a healthy specimen more than thirty years old, while all the older trees have now almost entirely disappeared from the neighborhood. Massachusetts planters, whether they plant for ornament or for profit, have no occasion to go far beyond the limits of their State to seek material for their plantations of oak.

The European beech (and its varieties), although, perhaps, less beautiful and certainly less graceful than its American prototype, grows and thrives in Massachusetts, if not as freely as in Europe yet sufficiently well to make it an interesting and valuable addition to all ornamental plantations here. The European birch, very like one of our smaller American species, and its numerous varieties, are graceful additions to our garden sylva, although not to be compared in beauty, vigor, and in economic value, with several of the birches native of this State.

The white willow of Europe (*Salix alba*) grows as freely and reaches as large size in Massachusetts as it does in Europe, and is now very generally naturalized in the neighborhood of all our principal centres of population. It surpasses in size and exceeds in value any American willow, and might be profitably cultivated wherever there is any demand in this country for willow timber.

The European poplars are inferior here to our native species in beauty, rapidity of growth and general usefulness, although landscape gardeners will find it difficult to produce certain effects without the pyramidal Lombardy poplar,

which, however, never reaches here a vigorous old age. The silver poplar or abele (*Popolus alba*) is here a very hardy, fast growing, although unsightly, tree, of no commercial value, and filling the ground in its vicinity with troublesome suckers. It should no longer be planted in Massachusetts.

If Europe has given us few valuable deciduous trees, its contribution of conifers to our plantations is still less important. It was once believed, and no one, perhaps, was more firmly impressed with this belief than myself, that the Scotch pine (*Pinus sylvestris*), one of the great timber trees of northern Europe, was destined to become an important economic factor in New England forests and plantations.* This opinion, based upon the deceptive and insufficient evidence of the early promise of this tree, was reached too hastily. The past ten years have shown that the Scotch pine is a failure in New England as an ornamental and as a timber tree. It is very hardy; it grows quickly and easily from seed, and young plants can be raised and sold more cheaply, perhaps, than the seedlings of any other coniferous tree. These are not fastidious about soil and are proof against any exposure or hardship. The young trees, during the first twenty years of their life, grow with astonishing rapidity, and then either die outright, from some as yet inexplicable cause, or begin to fail gradually, and perish long before reaching maturity. It has cost American planters something in money and a great deal in disappointed hopes to discover the worthlessness of the Scotch pine in this country. If, however, they have learned, at the same time, the folly of pronouncing upon the value of any exotic tree in any country, until it has been generally tried in that country during at least as many years as it requires to complete its individual existence, their experience with the Scotch pine has not, perhaps, cost them too dearly. The Scotch pine is still raised and sold in great numbers in some parts of the West, where the rapid growth and perfect hardiness of the young plants on the northern prairies make it indispensable in all wind-breaks and shelter plantations, at

* A Few Suggestions on Tree Planting, p. 27.

least in the opinion of men engaged in selling the plants to settlers.

The Austrian pine (*Pinus Austriaca*), less widely planted and less thoroughly tried in Massachusetts than the Scotch pine, promises also to prove a total failure here. The young plants grow rapidly and are very hardy, but they begin to fail early, and will probably disappear entirely before they are fifty years old. This species is liable to suffer from the attacks of wood-borers in the main stem. The cultivation of the Austrian pine in Massachusetts should now be abandoned, and our native red pine (*Pinus resinosa*), a more beautiful and in every way more valuable tree, substituted for it. The Corsican pine * (*Pinus Laricio*), of which the Austrian pine is merely a variety, once promised to become valuable in the forests of southern Massachusetts. It has now been shown, however, that this tree is not hardy in our climate.

The Norway spruce (*Picea excelsa*) has for many years been the most widely distributed and most generally cultivated foreign tree in Massachusetts. This tree, thirty years ago, had much, apparently, to recommend it to American planters. It is cheaply raised and easily transplanted; the young plants grow with surprising rapidity and vigor, and are hardly surpassed in grace and beauty by the young of any other of the spruces which will thrive in our climate. The general introduction of this tree into our plantations must nevertheless be regarded as a public misfortune. It has added nothing to their permanent value and it has interfered with the cultivation of more valuable native trees, like the white pine, the white spruce. The Norway spruce, in spite of its early promise, must be acknowledged to be a complete failure in eastern America. It has passed its prime here and is almost decrepit before it is half a century old; it will never produce timber here, and it becomes unsightly just at that period of life when trees should become really handsome in full and free development.

It remains to speak of the European larch. Something more is known of this tree in Massachusetts than was known

* A Few Suggestions on Tree Planting, p. 15.

ten years ago,* but not enough yet to speak with anything like certainty of its real and permanent value in Massachusetts plantations. The European larch, at least during the first fifty years of its life, grows here in Massachusetts more rapidly than our American larch, and more rapidly than most coniferous trees of equal economic value.

The following table of measurements of thirty-three trees of European larch recently cut in the Arnold Arboretum will give some idea of the rate of increase this tree may be expected to attain in this State. These trees grew upon the top of a very exposed hill, fully open to the northwest, in good loamy soil about eight inches deep, insufficiently drained, and underlaid by a heavy gravel subsoil. The growth made by these trees seems, under the circumstances, to have been satisfactory. They increased in height at a rate equal to considerably more than a foot a year, and in diameter of trunk more than a quarter of an inch a year, during the whole period.† They would doubtless have made more wood in a better drained and more open soil, although their annual average increase compares favorably with that attained by this tree in Scotland, where, however, it is also an exotic.‡ Every specimen was sound and vigorous when cut, and was still increasing rapidly in diameter. The measurements of maximum diameter were taken two feet above the ground, the minimum diameter three feet feet below the extreme tips of the trees.

* A Few Suggestions on Tree Planting, p. 29.

† A number of white pines (*P. Strobus*) had been planted on this hill, and had grown under the same conditions as the larches. Twenty-two of these pines were cut in November, 1885. They were all either sixty-four or sixty-five years old and had reached a height varying from 52 to 79 feet, with a diameter of trunk, two feet from the ground, varying from 17 to 22 inches.

‡ See for the growth of European larch in Scotland, The Forester, by James Brown, 5th ed., p. 722.

TABLE OF MEASUREMENTS OF THIRTY-THREE TREES OF LARIX EUROPÆA CUT IN THE ARNOLD ARBORETUM, NOVEMBER, 1885.

No.	Height.		Diameter.		Layers of Annual Growth.	
			Maximum.	Minimum.	Heart.	Sap.
	Feet.	Inches.	Inches.	Inches.		
1	58	1	12	2	33	18
2	58	8	14½	2	36	20
3	56	6	14	2	33	17
4	56	–	14½	2	35	18
5	55	–	14	2	30	16
6	56	6	14	2	35	15
7	56	3	12	2	28	18
8	55	–	13½	2	32	17
9	36	6	8½	2	24	14
10	58	4	13½	2	29	17
11	57	–	14	2	30	18
12	63	9	13	2	33	19
13	58	8	12½	2	32	14
14	39	7	11	6½	29	16
15	55	10	11½	2	33	13
16	55	8	14¼	2	34	19
17	57	8	11½	2	30	14
18	59	7	13½	2	29	16
19	59	10	10½	2	36	14
20	50	2	12½	4½	31	15
21	56	4	12	2	35	13
22	56	7	11½	2	33	15
23	56	11	12	2	34	15
24	61	–	13½	2	35	17
25	38	9	12	5	32	14
26	50	–	12	5	36	17
27	60	2	12	–	33	17
28	48	3	11½	2	34	13
29	55	7	14	2	36	16
30	56	2	14	2	33	16
31	33	6	8	2	24	15
32	39	3	10	2	35	16
33	46	10	12	2	31	17

Specimens of the heart wood, taken two feet from the ground, from Nos. 9, 12, 18, 19 and 31, — that is, from individuals fairly representing the average of the age and development of all the specimens examined, — were submitted to Mr. S. P. Sharples, who has determined their specific gravity and per cent. of ash, in the same manner that similar determinations have been made by him upon the native woods of the United States.* The wood upon which these determi-

* Final Reports 10th Census of the United States, vol. ix., pp. 247 *et seq.*

nations were made was artificially dried until it refused to give off moisture, and was therefore absolutely dry.

LARIX EUROPÆA.

No.	Specific Gravity.			Ash.		
	Determinations.		Average.	Determinations.		Average.
9	0 4712	0.4139	0.4425	0.23	0.19	0.21
12	0.5723	0.5055	0.5399	0.10	0.07	'0.08
18	0.5823	0.5714	0.5768	0.16	0.10	0.13
19	0.5506	0.5494	0.5500	0.07	0.09	0.08
31	0.5172	0.5139	0.5155	0.16	0.16	0.16
	Average, . . .		0.5249	Average, . .		0.13

It is interesting to observe that the oldest and largest trees produced the heaviest and therefore the most valuable wood, but even after omitting the two small trees, Nos. 9 and 31, from the average, this test, if it is acknowledged that the specific gravity of any wood is the best general indication of its value for fuel or construction, does not suggest any remarkable value in European larch wood grown in Massachusetts. The heaviest of these pieces of European larch wood (0.5823) is much lighter than the heaviest piece of native larch wood (0.7779) tested in the same manner in the United States Census investigations, while the average of the specific gravity of fifteen specimens of the native larch then tested was 0.6236 against 0.5249 for the ten specimens of European larch tested. This Massachusetts-grown European larch wood is heavier and harder, nevertheless, than many American woods. It is heavier than the wood of the Douglas or Oregon fir, the most valuable timber of western North America, and of the western yellow pine; it is heavier than any pine wood grown in Massachusetts, and it exceeds in specific gravity the wood of all the firs, spruces and hemlocks of the United States.*

The European larch grows rapidly upon the poorest soil

* Sargent, The Woods of the United States, Table 11, p. 153.

of Massachusetts; it has begun even to reproduce itself here spontaneously, and there is good reason for believing that it will become a long-lived and valuable tree here. The wood which it produces here is hard, solid and durable, and well suited for fencing and railway ties. It is doubtful, however, if it is desirable at present, at least, to introduce this tree generally as a permanent timber tree into Massachusetts. Sufficient time has not elapsed since its first general cultivation in New England to make it certain that the larch will not, before reaching full maturity, like so many other European trees, utterly disappoint the planter. It is doubtful, too, in spite of all that has been written — and no one has spoken more strongly upon this subject than I — about the advantage to be derived from cultivating this tree in Massachusetts, whether the European larch can properly have any permanent place in our forests. Indeed it seems to be more evident every year that the European larch can do nothing for us which some of our native trees cannot do better and more economically. The larch will grow and make timber rapidly upon poor soil; but soil which will produce good larch timber will produce white pine, and white pine is a far more valuable article commercially than larch. Larch timber is valuable here for fence posts, railway ties, and similar purposes, where durability with contact with the soil is necessary. The wood of our native chestnut possesses these qualities to an admirable degree, and the chestnut will flourish on land not much better than that which will produce larch. It is now known that chestnut railway ties are far more valuable than larch ties, and the chestnut can be more cheaply and easily grown than the larch, and will make timber more rapidly. In a State, therefore, where the native white pine will thrive upon its poorest land, and the native chestnut can be depended upon to furnish posts and ties economically, it does not seem necessary to introduce a foreign tree, especially when no more is known about it than is now known about the larch, whose only real merits are that it will flourish upon poor soil and produce durable timber. This tree can perhaps, however, be profitably grown in the region north of Massachusetts, beyond the natural range of the chestnut, and where no native tree pro-

ducing such durable wood as rapidly as the European larch is to be found.

Many of these facts relating to the behavior of European trees in this country are now well known to nurserymen and other experienced planters. People nevertheless continue to plant foreign trees, and especially European trees, very largely. Probably where one native tree is now planted in Massachusetts, five foreign trees are planted here, and this in a region where the native forest is rarely surpassed in the individual beauty and value of the trees that compose it. The cause of this unfortunate condition of things will be found in the ignorance and indifference of planters, and in the shortsightedness of nurserymen who supply them with trees. The fault, if fault there is, in this matter, lies with the purchaser, however, rather than with the seller. The nurseryman, as long as he can find a market at good prices for cheaply grown foreign trees, can hardly be expected to sacrifice immediate profits in creating a demand which does not now exist for better material, wise as such a policy would doubtless be for him in the long run. When Massachusetts planters study trees in Massachusetts woods and fields instead of in the trade catalogues of foreign and domestic tree dealers, and thus learn to take advantage of the wonderful sylva which nature has spread over eastern America, our plantations will attain an importance and value now unknown to them. In the meantime nurserymen will continue to raise and planters will continue to purchase the very trees which over and over again have proved themselves utterly unfit to receive any place in our plantations. The mistake is discovered and the lesson is learned in the end, but only at the price of serious disappointments, and generally only when it is too late to take advantage of such dearly bought experience.

Massachusetts, in spite of our many sins of omission and commission, has made some substantial progress in the art of sylviculture. Her most instructive plantations, however, are not those which have been made upon the European fashion, or rather with European trees, by men who have studied the subject in Europe or in European books upon forestry, instructive and valuable as all such plantations have

certainly been in showing us what to avoid. The real progress in sylviculture in Massachusetts has been made by the farmers of Barnstable and Plymouth counties, who have taught us how to plant and raise forests successfully and profitably under the most favorable conditions. The secret of their success must be sought where they sought and found it, not in foreign treatises, unsuited to the requirements of this community, but in the native woods, in full view of their own doorsteps, which told them what to plant and supplied them with material for planting.

It has been demonstrated in Barnstable County that a crop of pitch pine can be raised from seed with as much certainty as a crop of corn, and with much less expense; and that the loose and shifting sands of Cape Cod, useless for every other purpose, can, with the aid of this tree, be made to bear valuable crops of wood. *

Not less interesting, certainly, and perhaps even more suggestive of future development towards the true policy for New England forest management, are the white pine plantations made forty or fifty years ago in Middleborough, Raynham, Bridgewater, and other towns in that part of the State. These plantations † were made upon barren, sandy soil, entirely exhausted by long cultivation, with seedling pines dug in the neighboring woods. The young trees are set in shallow furrows, at odd times, without interfering with other farm work, and so with little expense to the farmer. A distance varying from five to twelve feet in different plantations was left between the trees, which, after planting, received no subsequent care or thinning. These trees, with few exceptions, have grown rapidly and with great vigor, and are now worth, on the stump, sixty to seventy-five dollars an acre; and men are still living in these towns who have cut and sold white pine saw-logs at the rate of $150 an acre, from seedling plants set by themselves. Here, no doubt, are the most successful and profitable attempts at

* An interesting account of these pitch pine plantations, which already cover more than 10,000 acres in the aggregate, appeared in the Report of the Connecticut State Board of Agriculture for 1877-8, from the pen of Mr. J. H. Bowditch.

† Mr. Avery P. Slade, of Somerset, first described these white pine plantations in a lecture delivered in Boston before the Massachusetts Horticultural Society on January 17th, 1885, and which was afterwards published in the transactions of the Society.

sylviculture ever made in the United States, not even excepting Mr. Zachariah Allen's earlier plantations made in Rhode Island with native deciduous trees.*

These plantations are valuable, not in the great amount of timber which they have produced, but because they show how our farmers, with a trifling outlay, can improve their farms, by covering worn-out and unproductive land with a valuable crop, which, if left to mature, will continue to increase in value for generations. They show that white pine, the most valuable tree in New England, can be successfully and profitably cultivated; but unfortunately they do not yet show the method of culture which can best be adopted in order to make this tree yield the greatest returns.

More experiments and more comprehensive experiments with the white pine are needed. No one knows yet how to raise a crop of white pine seedlings from seed grown in the open fields, with the same almost absolute certainty with which a crop of pitch pine can be raised. No one knows whether it is better to plant white pines four feet apart or twelve feet apart, and no one knows at what period of their growth the young plantations should be thinned, or whether they should be thinned at all. There are abundant theories upon all these subjects, but they are theories unsubstantiated by the long and carefully conducted experiments actually necessary before the most economic and profitable method for the cultivation of any timber tree can be determined upon. This is a subject of great importance to the agricultural prosperity of New England. The original supply of white pine is rapidly disappearing before the constantly increasing demands for this lumber, and white pine logs must inevitably become one of the most valuable of all American products. The climate and soil of a great part of New England are peculiarly suited to the white pine. Nowhere else are there now such extensive, vigorous and thrifty young forests of this tree as may be found in many parts of New England; and nowhere is it growing with greater promise than upon the exhausted and abandoned fields of this State. It will give to these fields, one of these days, a value which they have never possessed before, and

* Notes on Trees and Tree Planting, p. 20.

of which their owners have probably but little idea. It is clearly for the interest of New England to protect and extend these young plantations; to guard them from the fires which are everywhere and always threatening their destruction, and not only the destruction of the trees themselves, but the ability of the soil to bear them. It is clearly for our interest, too, with so much land unfit for almost any other crop, to learn by actual experiment more about the requirements of this tree in cultivation, and to learn, if possible, how to plant forests of white pine economically, and how best to guard and develop the young forests which are springing up naturally.

There are other trees besides the white pine which the farmers of Massachusetts can cultivate with profit. The wood of some of the native trees of Massachusetts is in great demand, and will soon become rare and expensive everywhere. The best hickory has already been cut, and as no wood has ever been found to take the place of hickory for the particular uses to which that wood is applied, and as there is no hickory except in the United States, the value of any farm can now be increased by a plantation of hickories. White ash of good quality has also become very scarce, and there can be no loss in planting this tree wherever good land can be spared for it, or in protecting and encouraging the young plants wherever they have sprung up spontaneously. Chestnut, too, must always be in demand for railway ties and fence posts, and there are rocky and unproductive hills in every town in the State, which might profitably be covered with groves of this tree.

This question of a supply of railway ties is now so interesting to the students of forest statistics, and as the farmer sooner or later will have, here in New England, at least, to raise the ties for the railroads, it will not, I hope, be out of place if I add to these notes about trees what little I have been able to learn in the last few years in regard to the value of different woods for this purpose.

The Boston and Providence Railway Corporation began in 1878, at my suggestion, an experiment for the purpose of determining the value of different woods for cross ties. Fifty-two ties were laid on the 12th or 13th of December,

under the direction of Mr. George F. Folsom, master carpenter of the corporation, who has had, from the beginning, the entire charge of the experiment, in the main outward track, at a point beginning 775 feet west of the Tremont Street crossing in Boston. The traffic at this point is very heavy, an average of sixty-five trains passing over this track daily.

The following ties were laid: —

Nos. 1 to 3, American Larch.
Nos. 4 to 12, White Oak.
Nos. 13 to 18, European Larch.
Nos. 19 to 24, Western Catalpa.
Nos. 25 to 30, Ailanthus.
Nos. 31 to 36, Black Spruce.
Nos. 37 to 38, Southern Hard Pine.
Nos. 39 to 40, White Elm.
Nos. 41 to 46, Hemlock.
Nos. 47 to 52, Canoe Birch.

The European larch ties (Nos. 13 to 18), were cut from trees grown in the plantation of the late Richard S. Fay, near Lynn, in Essex County, about thirty years old. The catalpa ties (Nos. 19 to 24), were furnished by the late E. E. Barney, of Dayton, Ohio, who for many years before his death was zealously engaged in making known the value of the catalpa tree, and the remarkable durability of its wood. The ailanthus ties were from the trees grown in the town of Bristol, R. I.

The remaining twenty-two ties, spruce, hard pine, elm, hemlock and canoe birch, had been creasoted by the Hayford process, and were included in the experiment at the request of Mr. Edward R. Andrews.

One American larch tie had to be removed from the track in October, 1883; it will probably be found necessary to remove the other ties during the present year.

One white oak tie had become so worn that it had to be removed from the track in October, 1883. The remaining eight are but little worn, and will probably last for many years longer.

Of the European larch, four were worn out and taken from the track in June, 1883; one in October of the same

year; the sixth and last will be removed during the present year.

The catalpa ties have all been taken from the track, two in June, 1883, one in July, 1884, and two in October, 1885.

The first tie of the fifty-two to give out was an ailanthus, removed in November, 1882; two ailanthus ties were taken out in October, 1883, and two in July, 1884; one still remains in the track, but little worn and apparently as sound as when laid down.

Two spruce ties were removed in July, 1884; the remainder will have to be removed during the present year.

The two ties of southern pine are already so greatly worn that it will be necessary to remove them from the track during the present year.

The hemlock are now badly worn, and it will doubtless be necessary to take them from the track during the present year.

The two elm and the six birch ties are perfectly good and sound, and show but little indication of wear.

This experiment is not yet completed, and this statement of the behavior of the different woods, which Mr. Folsom has prepared, is, of course, only preliminary to a more detailed report upon the subject.

None of the ties which have been removed from the track were decayed, with the exception of the ailanthus taken out in November, 1882; and this stick was defective and partly decayed when laid down. The other ties taken out have been worn out by pressure, and not by decay. The whole mass of wood directly under the rail has been so crushed and disintegrated, to the depth of the spike holes,—5½ inches,—that the spikes have no hold upon the tie, which has to be abandoned. This experiment, if it has done nothing else, has confirmed the opinion of the most experienced railway engineers, that ties do not rot out, and, therefore, ability to resist decay in contact with the soil is a less important quality in a wood to be used for this purpose than ability to resist a direct crushing and wearing pressure.

The experiment shows, as might have been expected from the specific gravity of the two woods, that the American-

grown European larch was inferior to the native larch, and that neither of these woods give any remarkable promise of value for this purpose.

The behavior of the catalpa is one of the most interesting features in the experiment. Great attention has of late years been given, in some parts of the country, to the cultivation of the western catalpa, and it has often been stated that its practical indestructibility when placed in the soil would make it one of the most valuable woods for railway ties.

The catalpa is a soft, light wood, with a specific gravity of only 0.4165; and it has not shown its ability to resist the heavy and constant traffic of the Providence Railroad as well as white oak and other heavier and harder woods. The two catalpa ties taken from the track in October, 1885, that is, after four years and eight months' service, are perfectly sound except under the direct bearing of the rails. These had cut down into the wood to the depth of five-eighths of an inch, while the whole mass of wood under the rail is reduced nearly to pulp by the separation of the layers of annual growth and the breaking of the fibre. This disintegration has penetrated so deeply that if the ties, otherwise perfectly sound, were turned over, the wood which would then come under the rail would not have sufficient thickness to hold the spikes. The pressure, however, to which these ties have been subjected has been unusually severe, and there is nothing in the behavior of these catalpa ties to show that they would not, in a road with lighter traffic, have stood for a number of years, and resisted as well and probably better than ties made from any other equally soft and less durable wood. The result thus far obtained with the ailanthus wood is not satisfactory; the wood was not well selected, and one tie was practically useless before it was laid. Ailanthus wood, however, is hard and solid and will probably make excellent ties.

The spruce, southern pine and hemlock, although creasoted, did not give much better results than the uncreasoted larch, and it is evident, therefore, that it will not pay to use any of these woods for this purpose.

The result, on the other hand, with the creasoted elm and birch has been highly satisfactory. These are hard, solid

woods, but so liable to decay in contact with the soil as to be unfit for ties unless protected by some preserving process. Elm and birch are easily cultivated and grown with rapidity; and as ties of these woods can be sold cheaply, they should, with a cheap and effective preserving process, form important factors in the tie supply of the Northern States.

The white oak has proved the most enduring of all the uncreasoted ties laid down for this experiment; and white oak would make the very best tie which could be raised in New England, were it not that it holds spikes so firmly that it is practically impossible to draw them, when it becomes necessary to shift or change the rails. For this reason chestnut, unfortunately not included in this trial, makes, all things considered, a better tie than oak, and the best tie which can be grown in Massachusetts. It is durable, solid, and withstands crushing better than almost any of our native woods in their natural state, always excepting the white oak. It is easily raised and thrives upon rough and rocky land unsuited for tillage. The chestnut tree suckers freely and vigorously from the stump when cut, and in this way will continue to produce three or four crops of tie timber. The inferences which it is, at this time, safe to draw from this experiment are, that for Massachusetts railroads chestnut and white oak make the best ties; and that other hard, compact and low-priced woods, like elm and birch, not naturally durable enough for the purpose, can be made valuable through some preserving process.

PROTECTION OF TREES AGAINST INSECTS.

CHARLES B. RICE OF DANVERS.

Mr. Chairman and Gentlemen of the Board of Agriculture.

I am glad of an opportunity, by your favor and through the courteous invitation of your Secretary, to speak briefly of some measures that might be taken, properly and profitably, as I think, for the protection of our fruits, trees and field crops against the ravages of insects. For a long time it has appeared to me that we were in the habit of allowing ourselves to be overcome by the insect tribes after a helpless and humiliating and unmanly fashion. Of late years my own premises have been eaten and crawled upon, by the canker-worm especially, to an abominable extent; and having tried private warfare to no conclusive result, I was led to think, after the custom of a New England man, that the enemy ought to be attacked by some form of legislation. I had, however, along with the spirit of valor, enough of discretion to understand that it would not be best for me to undertake to haul out the artillery of the State House alone, and that I might better, first of all, confer with some person who had much more knowledge than I possessed respecting the strength and number of the enemy, and the manner in which the campaign against him should be conducted, if indeed it were best to enter upon it at all. And thus I called upon the Secretary of your Board.

What I have to say is briefly under this head: that there certainly ought to be taken some general, concerted, public and effective measures for protection against insects; that it is clearly possible to do something effectively; that it is unprofitable to us as husbandmen and discreditable to us as men to neglect it. Let me illustrate what I mean by my

particular personal enemy the canker-worm. (My trouble with him is not in Franklin County, but in Essex County, where I have at present my place of living.) You all know the nature of the insect and the extent of the mischief he does. One man, the owner of apple trees or elms, can keep him off his own trees, with the old methods of protection, by very careful and thorough work continued through several months of each year. Or he can do it with one or two applications of paris green, late in May or early in June. But if his neighbors do not all of them do the same thing, he will have to go over the work for himself the next year, and year after year, indefinitely. And besides the great trouble and expense involved by the continuance of these applications with so many persons each year, even with the cheapest remedy, the paris green, there is an unwillingness on the part of many to use this poisonous substance thus freely, year after year, scattering it upon the grass beneath the trees, and in the way often of fowls, and not long before the time for cutting the grass. I think there is some basis in reason for this aversion to its use. At any rate there is a great and continued and needless trouble and expense, and to little purpose. There ought to be some public provision for the application of the paris green upon all the orchards and shade trees in the infected districts. And if this were done for two years, and possibly even for one year, the whole plague would be ended, or ended certainly for a long time. Some of the worms would doubtless survive and remain; enough, I think, to oil the wheels of nature. And if their numbers were once very greatly reduced, it is probable that for a period of years their natural enemies, the birds, would keep them within due bounds. (For to some extent the birds eat them.) In time they might multiply again, under the law of fecundity which prevails so far among the insect tribes, and then they could be again reduced in the same manner.

What I have said of the canker-worms applies, in the principle and substance of it, to very many other insect pests. Their powers of locomotion are such, and they have such fecundity in increase, that one man cannot easily and cheaply, and often not possibly, protect himself against them without

the concurrent action of all his neighbors. And all his neighbors are not usually, or scarcely ever, disposed to act effectively together without some public provision to that end. There is precisely the same basis of necessity and reason for legislation in this matter that there is for protection against the spread among domestic animals of contagious diseases. And while the occasion is not so startling, and may not seem so alarming, yet it may be doubtful whether the losses by neglect are not fully as great. The necessity is greater than with noxious weeds, because the insects spread more widely and rapidly, and because it is much more nearly impossible for one man to take care of himself alone, — and much more uneconomical. Though I think the provision for the weeds should be made.

I am sure you are fully aware, gentlemen of the Board, of the extent of the ravages the insects commit upon us, and with respect to almost all the fruitage and foliage and vegetation that grows in our fields. That "unspeakable Turk," the curculio, puts his crescent mark of sovereignty and destruction upon ninety-nine one-hundredths of all the fruit, plums, cherries and apples, that fall prematurely to the ground in Massachusetts. And he leaves it, indeed, on a large part of all these fruits that ripen; though with these there has been less of injury, and sometimes none. The caterpillars of different sorts have their years of destructiveness. The grasses and the trees in the forest have their enemies. Altogether the losses are enormous.

I admit that it is not so easy to say, in every case, what remedy should be applied, as it is with the canker-worms. But that is no reason for not making the organized public effort. The greater the difficulty, the greater is the urgency for trying the best means of relief. There is need of a public care to *find out* remedies as well as to apply them. There ought to be provision for the systematic and continued studying of the habits of the insects, and for the discovery of the best means of lessening the injury they do. The matter is one of time and labor and expense, and of public necessity; and it ought not to be left to the haphazard observation and experiments of individuals, or to the enthusiastic study, even, of here and there a naturalist.

I will not undertake to say precisely what appointment the State should make in this regard. Perhaps more can be done, in the line of study and observation, at the State Agricultural College, where much has been accomplished already.

But concerning the application, at least, of whatever remedies may be known, and for the executive part of the business in hand, it seems to me clear that there ought to be a State officer (one, or a board of officers) that should have power to act in their discretion and as the necessity of the case might require, and subject of course to proper limitations as to the scope of their work and the expense involved. We need a commander-in-chief against the canker-worms, "Turks" and caterpillars. The same man or men might have charge, also, of the business of weeds by the roadside, and might make public war against Canada thistles and the wild carrot. There is no special difficulty in the way. The best of all arrangements might be that which should give the full needful authority to the Secretary of this Board himself, concerning whom it is not necessary to say seriously that no man in the Commonwealth could do the work with more wisdom or efficiency.

It may be said that this is against the genius of our institutions, by which all things possible are left in individual hands. But it is not. I think, as we all do, that the government ought to let us alone in all things that we can manage practically for ourselves. But this, as I have shown, is not such a thing.

Moreover, we find everywhere, as a country grows populous and its industries numerous and varied, that some interference of the State is required in things which, at first, did not need to be meddled with. The increasing necessity for inspection, with regard to poisons and adulterations of food, is an instance in this line. As with respect to butter, butterines and oleomargarines, as to which, in early days and with simple ways of making and marketing, the individual seller and buyer might take care of himself, as he cannot now. Farmers are entitled fairly to a share of this public consideration and protection, of which, I think, relatively, they get none too much.

It is to be remembered, too, as to this matter, both of insects and of weeds and vegetable pests, that the original balances of nature upon our soil have been greatly broken up by the settlement of the country; by the clearing, in part, of the forests; the reducing greatly the proportionate numbers of the birds, and by many other changes in vegetable and animal life involved in the increasing occupation of the country. We cannot depend now upon nature alone to do for us what nature, if left alone, might have done. The evil has reached a great height already, both as to weeds and insect enemies. The organized intelligence and skill of man himself have need now to be brought into action to remove or turn back the mischief that the occupation of the country by man has incidentally brought upon us.

This is every way a becoming and manly business. The possession of the earth has been assigned to us men, with dominion over all life upon it. We have begun from the early years to take up a little this dominion over the cattle; and the oxen plough and the dogs bark, and bite, in our behalf — and sometimes yet to our despite. The fish of the waters, I believe, you are beginning to plant a little in the great ponds and rivers. The "fowl of the air," what remain, we can shoot or catch, or better leave alone. But these creeping things, that creep upon the face of the earth, have had their own way with us from the beginning of the creation, and have crawled upon all things we have need to grow for our use, very much as they have pleased. It is a reflection upon us as rational men, and the rightful sovereigns of the earth, that we have suffered it to be so, thus far and to so great a degree. I am here, therefore, Mr. Chairman, as one of the owners and rightful sovereigns of the earth, as well as one of the citizens of Massachusetts, to protest against our further allowance of this usurpation by the insects, and to ask for your help in taking more vigorous steps to bring these creatures into reasonable and appropriate and profitable subjection to ourselves.

It is suitable that Massachusetts should take some lead in such a matter. The business is not visionary, but clear and practical. I did not wish to make petition to the General Court, having practical acquaintance myself with its meth-

ods, without some consultation with your Board or this Society. Having laid the case thus briefly before you, I rely confidently upon your fuller knowledge and more practical judgment to determine what may properly be done or attempted.

Allow me only farther to suggest, that if it should appear that some action by the State might reasonably and profitably be taken, we should not be hindered from attempting it by any form of ridicule, growing out of the nature of the subject, or by any difficulties in the way of pressing it through. Ridicule we can stand, and can shortly turn off very decisively. Difficulties we can overcome, if we put our minds to it.

FARM LIFE.

By ETHAN BROOKS OF WEST SPRINGFIELD.

In these days of strife for power by means of those accumulations which represent multiplied dollars hastily gained, it may be well sometimes to take the more sober view of life, and to consider more carefully our real wants, never supplied till we comply with the edict following the first sin: "In toil shalt thou eat of the ground all the days of thy life."

It is sometimes said the farmer is the most independent of all men, and while at first thought this may seem to be true, we must remember that the tax gatherer always holds a first mortgage on our farms, and that our titles will soon lapse unless in a great majority of cases we draw from the bosom of mother earth the means of satisfying his annual demands.

We should also remember that by our very nature no man can be independent of his fellows, and that every branch of honest and useful industry is helpful to all other industries.

We are all familiar with the stubborn fact that the farmer household is beset with a full share of the perplexities and disappointments of life. The danger may be that of looking too intently at the discouragements, and of neglecting to see in their real light the advantages and enjoyments of farm life.

In no other calling can one have a home and a business so readily and so economically as in farming. In no other calling can one have, for anything like the same outlay, so much of a home as in farming.

To nothing else material can we look back, in the later years of life, with so much satisfaction as to our early home in the country.

Public improvements may demand that a city home be demolished and the surroundings so changed as not to be recognized, but in the country buildings may be removed and great changes may be made, still the prominent landmarks remain, — the same never-failing springs feed the same streams, — the same everlasting hills welcome us back, — and to these and kindred voices of nature we must join with the poet when he exclaims, —

> "Be it a weakness it deserves some praise,
> We love the play place of our early days."

To those who by choice or force of circumstances have their home on the farm there are many possible advantages.

Our buildings can be arranged so as to give us the greatest benefit of air, shelter and sunlight; our gardens may be so cultivated as to give an abundance of fruits and vegetables, in quality the envy of those dependent upon our city markets; while the satisfaction afforded in the cultivation and gathering of these luxurious necessaries is known only to those who have the right to enjoy it.

The surroundings of a *home* in the country give it its character.

With more acres on our farms than we can profitably cultivate, we may well devote a liberal portion to the comforts of home.

Modest buildings, with grounds thoughtfully laid out and carefully kept, with shade trees, which in the main should be fruit trees as well, at a proper distance, admitting sunlight, with grapevines so trained as to be useful and ornamental, are within the reach of every family allotted to abide on the farm. While the annihilation of distance by means of steam and electricity makes it a fault bordering on criminality if we neglect to avail ourselves of the general advantages of the age.

The *business* of the farmer, while it has many unpleasant features, has many advantages. There is always something for old and young to do. Children are never more content, or more directly in the way of the development of business qualities, than when doing something for themselves; and a brood of chickens, a calf, a colt, or the use of a plot of

ground, may, in many cases, wisely be given outright, as an incentive to honest, thoughtful industry. While all sources of supply are cut off to the laboring man in the city when work or ability to work fail, with the farmer, if he be only able to do a little, he may do that little and be in no man's way.

Depression in business does not throw us out of employment, and jealousies do not interfere to demand our place for some waiting aspirant.

Every well-managed farm will constantly increase in productiveness without a proportionate increase of expense, and as a rule will afford a steady and healthy income to supply the wants of our declining days.

We may not enjoy the *same* comforts and privileges as some of our cousins in the cities, but we should lead ourselves up to a higher appreciation and a firmer grasp of those privileges within our reach, and of those comforts which can be had without money, — many of which come only in connection with farm life.

We can never know just how much of any crop we can harvest, or just how much it will cost, or just what will be the market value; but what we lose in one season or on one crop, we may reasonably hope to gain on another, — for "it is a large wheel that never comes round,"— besides, it makes no difference what the selling value is of those products which we raise and must consume in our own families.

It must be acknowledged that in former years the farmer's wife and daughters had more than their share of care and labor as compared with their sisters in the towns and cities, but this need not and ought not longer to be true.

Co-operative dairying is a wonderful relief in its department; and the system of employing men and furnishing them houses, who can board themselves and the necessary extra help, now growing in favor, should be encouraged; thus giving to the family that quiet and freedom so necessary for the growth of the finer and higher qualities of our nature.

This may sometimes be more expensive than the old way, but the comforts are vastly greater, and is not a dollar's worth of comfort worth as much as a dollar's worth of anything else?

Irving, in his "Sketch Book," says: "The world has become more worldly; there is more of dissipation and less of enjoyment." And Vanderbilt, surrounded with his millions, said to his wife: "We took more comfort on the farm." The farmer, be he native born or adopted, as a rule, is a good citizen. He knows the necessity and the reward of honest industry and economy, and his sons and daughters, by reason of their early farm and home education, have something to fall back upon in later years, as adversity may compel or prosperity permit.

One of our most thrifty Western Massachusetts farmers insists that any ordinary family of half a dozen persons can get a living by going to work on ten acres of our average New England land. They may not indulge in luxuries, but their needs can be supplied.

In most of our New England towns farms can be bought at very low rates.

In most of our cities there are many families either out of employment or dreading the day when "slack work" or the absolute "shut down" shall bring the wolf to their door.

When a considerable proportion of these resort to the farm and go to work for a living, — giving up the idea of getting rich, — we shall hear less of strikes and communism, and shall know more of that peace and security that comes of honest industry. Farming is a slow process, and the farmer must be patient and hopeful. Not every one is suited to farm life.

The man who thinks of those wonderful laws of nature which control plant and animal life, rather than of the dirt on his fingers, and who finds his recreation in pruning and training his vines and trees, and in making beautiful the surroundings of home, while keeping in mind the fact that an income must be had to meet inevitable expenses, is the man to be happy and prosperous in farm life.

Years ago it was declared, "Man never is, but always to be, blest."

Those tribes of our race, and those individuals, who are quite content, are not progressive; and while very few farmers, even if well able, care in their later days to exchange

their surroundings, many in other callings anticipate the day when they may own and enjoy the ideal home in the country.

> The statesman, lawyer, merchant, man of trade,
> Pants for the retreat of some cooling shade,
> Where, his long anxieties forgot,
> Amid the charms of some sequestered spot,
> He may *possess* the joys he thinks he sees,
> Lay his old head on a lap of ease,
> Improve the remnant of his wasted span,
> And, having lived a trifler, die a man.

RAISING CALVES.

By E. F. BOWDITCH OF FRAMINGHAM.

Of all the varied labors of the farmer none is more important than the renewal of his dairy stock by rearing calves; no work requires more judgment or is more worthy of personal attention. It is often neglected, left to the boys or hired help, attended to when field work is done, at irregular intervals, and the milk used is often burnt in heating or is fed cold.

The result is a loss of valuable animals, the promise of the dairy, from diseases that may readily be avoided by skilful care. The true method of raising calves is that designed by nature; but under our system we have bred cows that are too strong in milking qualities, or that give milk too rich in fat to be the suitable food for their young.

Nature intended that a cow should give just enough milk to raise its calf in the best way till it is about five or six months old. At the West, on large cattle ranges, there is no demand for milk, but the business is to increase the herds and improve the quality of the stock; consequently the only demand made upon the cow is that she shall have a vigorous calf each year and raise it to the best advantage.

With us the case is just the reverse: we require that a cow shall have a calf each year, but we also want to have her give two or three cans of milk per day for a few weeks after calving, if we are selling milk; or, if we are making butter, we want each cow to make from two to three pounds of butter per day.

I do not mean to state that there are any dairies that produce any such yield throughout the herd, but having perhaps

one such animal, we make her the standard. Undoubtedly much can be done when the calf is young towards fitting it to be a beef or a dairy animal, but to go through all the differences of feeding for both would take too long, and I will merely give a few suggestions as to the best practical plan of raising calves to replace our old cows, which should be part of the economy of every farm.

When the calf is dropped, first see that its nose is not covered by the membrane, its nostrils clear, and its breathing all right, then leave it with its dam undisturbed for a short time; put some dry bedding under the calf, and, if very cold weather, rub the calf to help the cow dry it, and thus prevent danger of getting chilled.

It is a good plan to give the cow a dose of from $1\frac{1}{4}$ to $1\frac{3}{4}$ lbs. epsom salts, with ginger and molasses added, immediately after calving, for two reasons: it assists to bring away the after-birth, and also to diminish the danger of milk-fever, which danger is always present at this time in a finely bred cow, even if not in high condition. If the dose has not operated in 14 or 15 hours give another dose not quite as large as the first one.*

If your cow is one of the milk-producing breeds you will probably have no trouble with your calf's scouring, if you do not let it have too much of the first milk, which acts as a cathartic.

If your cow is of a rich butter-making breed, great care must be taken to give but very little of the first milk, and the calf must be kept away from its dam, being allowed to suck but four or five times a day, and at each time allowed but very little of the first of the milking, which generally is not quite as rich. After the third or fourth day, when the milk is good, the calf should be taken away entirely from the cow and taught to drink, — slowly, if possible, — and now is the time when nature should be copied as closely as possible.

The milk, when fed, should be at the same temperature as when drawn from the cow, which is about 100°, and this

* Practical experience teaches that feeding the cow while dry, before calving, on linseed-oil meal has a very beneficial effect, by easing the act of parturition, and also diminishing the liability of milk-fever. Two quarts per day is enough to feed.

temperature should not be guessed at with the finger, or any other way, but always tested with a thermometer made for the purpose.

If calves are fed regularly for the first few days with a scanty supply of their mother's milk, skim milk can be used for one feed at first, then for two, and in a few days you can get your calf on skim milk, leaving you the whole milk for dairy or household purposes.

After a few weeks the calf will begin to eat a little rowen, and also a few bruised oats, bran, or linseed meal, or a mixture of the three.

Feed your milk clear without the addition of grain or gruel.

The calf begins to chew his cud when a few weeks old, and at that time needs dry food to bring his stomach in working order.

Exercise, both summer and winter, is very desirable. Calves born late in the spring or early summer are better kept in a paddock, near the barn, than turned out, when three months, to fight for life, and eat all sorts of grass, twigs, etc., which do them no good and often harm.

There are many teas and foods which are recommended as food for calves, but nothing makes so good an animal as cow's milk, when properly fed.

Sometimes there seems to be an epidemic among the calves, and in spite of all the pains taken, they will begin scouring, changing in a day or two to a bloody discharge. When this occurs, the skim milk fed should be cooked by setting the pail in boiling water. After cooking in this way for awhile, skim off all the rich scum which appears; feed very sparingly, when it has cooled to 100°, adding ½ pint lime-water, together with a table-spoonful of finely powdered charcoal. If this treatment fails, raw eggs must be resorted to (6 or 8 per day), with brandy. If the calf taken ill in this manner is of a valuable breed, the surest and cheapest way is to buy a cheap "skim-milk cow," and let the calf suck for itself.

Milk should be fed, if convenient, till the calf is 6 or 8 months old, and when stopped a little more grain should be added.

The first winter is quite an important period, and for that

reason I like calves dropped in the fall and winter, as in that case they are nearly a year old when the time arrives for stabling for the winter, and have already made good growth on pasture.

It is not necessary to feed the best of hay and rowen to grow good animals, for their stomachs are four in number, and nature intended them to be used. A good winter feed for a calf nearly a year old may consist of cornstalks, straw or rough fodder, with a mixture of cornmeal, cabbage and bran, and linseed-oil meal added in quantity enough to keep the bowels in good order, the whole amount of grain being $1\frac{1}{2}$ to 2 quarts per day.

Fed in this way, heifers may be brought into milk at about 26 to 28 months old, be well grown and capable of raising a good calf, giving 10 to 12 quarts of milk or making over a pound of butter per day.

MASSACHUSETTS AGRICULTURAL COLLEGE.

To the State Board of Agriculture.

Having been appointed by this Board a committee to visit and examine the Massachusetts Agricultural College, we desire to submit the following

REPORT.

As there has always been some uncertainty in the minds of some of our number in regard to the powers and duties of the Board of Overseers of the college, and the extent of authority which they could confer upon their committee, our first efforts were directed to the inquiry as to whether we had legally and properly any active duties to perform, and if so what those duties were.

The act of Congress giving public lands to the several states and territories which may provide colleges for the benefit of agriculture and the mechanic arts, was approved by the President, July 2, 1862.

The legislature of Massachusetts, after accepting the grant offered to it by the United States, and making other necessary provisions in relation to the donation, passed an act, in 1863, constituting Marshall P. Wilder and others a body corporate by the name of the trustees of the Massachusetts Agricultural College, and defined their duties.

The same year (1863) the legislature, after conferring the necessary powers upon the trustees for establishing and sustaining the college, reserved to the Commonwealth the right to alter, limit, annul or restrain any powers vested by their act in the corporation, "and especially to appoint and establish overseers, or visitors of the college, with all necessary

powers for the better aid, preservation and government thereof."

In 1866 this right was exercised, and the State Board of Agriculture was empowered to appoint overseers of the college from its members, and the act provided that their duties should be defined and fixed by the governor and council. We are informed that from time to time the Board of Overseers had applied to have their duties "defined and fixed," but no action had ever been taken in the matter, and that from the appointment of Alexander Hyde and William Birnie, the first committee of this Board, who made their report in 1867, to the present time, each committee had acted upon its own judgment and responsibility.

Although we may not perhaps have any legal duties to perform until our duties are defined by the governor and council, unless custom makes law, your committee have "followed in the footsteps of their illustrious predecessors," and acted upon their own judgment.

For many years a report of the committee on the college was faithfully made and printed in the Secretary's reports. The overseers seemed to take this view of the duties of their office, that they were the representatives of the Commonwealth, and although the trustees were the executive officers of all the immediate affairs concerning the college, they could hardly do without the State to stand by and sustain them, and that the members of the State Board were made overseers in the language of the act, "with all necessary powers for the better aid, preservation and government" of the college, — in other words, they were to examine and take notice of everything pertaining to the college as the representatives and for the protection of the Commonwealth.

Your committee taking this view of their duties, it has been their purpose to investigate everything about the college as minutely as the reasonable exercise of their trust would permit, in order that you might the better determine whether the citizens of this Commonwealth are receiving the fair and proper compensation for the generous appropriations which are constantly being made in behalf of this institution. Our first official duties at the college began with the graduating exercises in June, when your committee were

all present, excepting Mr. Buddington, who was detained by severe illness.

On the 22d of June your committee were present at the examination of the graduating class for the Grinnell prizes. It will be remembered that Hon. William Claflin of Boston gave the sum of $1,000 for the endowment of a first prize of $40 and a second prize of $25, to be called the Grinnell Agricultural Prizes, in honor of George B. Grinnell, Esq., of New York. These prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

The graduating class consisted of ten young gentlemen, whose names were: Edwin W. Allen, of Amherst; L. J. Almeda, Brazil; George H. Barber, Connecticut; Charles W. Browne, Salem; Joel E. Goldthwait, Marblehead; Hezekiah Howell, New York; Lewis C. Leary, Amherst; Charles S. Phelps, Florence; Isaac N. Taylor, Jr., Northampton, and Benoni Tekirion, Turkey. The examination was intended to conform to the requirements of the endowment, — to be oral and written, in theoretical and practical agriculture. The oral examination was conducted mainly by Prof. Miles, the Professor in Agriculture, upon twenty printed topics. The students were each called up twice, and were not supposed to know which of the twenty subjects they were to be examined upon; and they acquitted themselves very satisfactorily, showing a *fair* knowledge, at least, of the various subjects under consideration. They had evidently studied hard to understand the "science of agriculture," and the examination embraced the various departments which relate to the interests of the farm.

Each of the young men submitted an essay upon a practical topic, — the rotation of crops, — written without the aid of any text-book, or any other aid, except what his own knowledge supplied. Some of these papers were quite able productions, and most of them showed a very good knowledge of the subject.

Military Drill.

Immediately after the examination in agriculture there was a military drill, under Lieut. Bridgman, Professor of Military Science and Tactics, which was very interesting, and was witnessed by a great number of people.

Lieut. Bridgman is an able instructor in military science, and has taken great interest in his college duties.

The examining committee of this Board in 1871, of which Prof. Agassiz was chairman, in reporting upon this part of the college requirements, says: —

"No one could look upon that company of young men without realizing the wisdom and foresight of those minds that originated the idea of requiring 'military tactics' to be taught in agricultural colleges. The influence of their military training was so manifest, not only upon their general physical health and development, but also in indispensable attributes which help to make up a true gentleman, that we do not believe too much importance can be laid upon this branch of their education, both as exerting a healthful influence upon the students themselves and as a safeguard for the protection of our country in the future."

Your committee were as favorably impressed with the importance of this branch of training in the college as was our distinguished predecessor. It has a tendency to develop a manly bearing, promote health, confer confidence and promptness of action, and it serves to insure a proper sanitary condition of the college, as the commandant makes a careful inspection of all rooms and college buildings each week, at stated times.

The military drill on the parade ground of the college is one of the most pleasing and attractive entertainments to visitors of any that are witnessed during the examination days, and one that is entered into with great relish and pride by the students.

Battalion Organization and Prize Thesis.

All students, unless physically disqualified, are required to attend prescribed military exercises, and those who pursue

special or partial courses at the college are not exempt, so long as they remain in the institution.

For instruction in infantry tactics and discipline the cadets are organized into a battalion of two or more companies under the commandant. The officers, commissioned and non-commissioned, are selected from those who are best instructed and are the most soldier-like in the discharge of their duties. As a rule the commissioned officers are taken from the seniors, the sergeants from the juniors, and the corporals from the sophomores. Essays are required from each senior, on military subjects, when they have been sufficiently instructed. These papers are read in the recitation room for general note and criticism, or before the entire college.

One set, all upon the same subject, are written for prizes, the award being made by a board of army officers. The successful competitors read their productions at the graduating exercises. After the close of the military exercises on the parade ground we attended the reading of these prize essays. They seemed to be able productions and showed much study and thought.

Farnsworth Rhetorical Prizes.

Isaac D. Farnsworth has furnished a fund of $1,500, the income of which is to be used as prizes, to be annually awarded under the direction of the college faculty for excellence in declamation.

These rhetorical exercises took place on the evening of the 22d. There was a large company present and the exercises were very interesting.

Graduating Exercises.

These exercises began at 10 o'clock, A. M., on the 23d of June. They consisted of written essays by each member of the graduating class, at the close of which Governor Robinson presented them individually with a diploma conferring the degree of Bachelor of Science, signed by himself as president of the corporation.

Alumni Dinner.

The second alumni meeting and dinner took place immediately after the graduating class received their diplomas. It was a pleasant affair, under the direction of Joseph F. Barrett of the class of 1875. Grace was invoked by Rev. Henry Hayne, a graduate in 1875, now rector of St. Matthew's Church, South Worcester; and after dinner addresses were made by Col. Daniel Needham, President Greenough, Senator Sessions, Wm. H. Bowker, Prof. Stockbridge, Herbert Myrick, and many others.

President's Reception.

President Greenough gave a reception at his house, on the evening of commencement day, which was attended by most of the students and faculty of the college, besides many of the professors of the older college, and many of the best people of the grand old town of Amherst. The president and his family seemed very happy in their new home, and all in attendance will long remember this brilliant occasion.

Students.

The college, perhaps, was never in a more prosperous and promising condition. Thirty-two young men are enrolled in the freshman class, and the new catalogue will show the names of one hundred and ten students.

Trustees.

Under the present system two trustees of the college retire each year, and their successors are appointed by the governor and council. Mr. J. H. Demond has recently been re-appointed, and Senator Root of Barre was appointed Jan. 1, 1886.

College Farm.

On the occasion of their visit to the college in June, your committee improved such part of their time as was not necessarily occupied in other ways, in looking over the farm, buildings and stock.

The college farm consists of 383½ acres, nearly one-half of which may now be said to be under cultivation. The farm may be considered under three heads: —

1st. That part leased to and occupied by the Experiment Station,—about 30 acres.

2d. That occupied by the Botanic Department, including nurseries, market gardens, mowing and wood lots, consisting of about 140 acres, about 90 of which may be under cultivation.

3d. The farm proper, lying west of the county road, of which some 75 acres is mowing and tillage. Of this, also, a considerable portion of the pasture has been ploughed, and admits of being brought into a general system of rotation of crops.

It was the unanimous opinion of the committee that the farm was looking exceedingly well, indicating good cultivation, and we were informed by the officers that the improvement was the result of improved methods of cultivation.

The farm lying west of the county road has been improved, during the past year, by re-seeding a considerable portion to grass, and the farm has been so managed, during the past year or two, as to nearly double the hay crop.

Prof. Maynard is also continually improving the Horticultural Department, by extending and improving the orchards.

The report of the farm this year gives 130 tons of hay, 40 tons of corn fodder, 1,300 bushels of shelled corn. We have been unable to ascertain the number of bushels of potatoes, grain, or other crops.

There were about 22 acres of corn, 60 acres of grass, 5 acres of oats.

Stock.

The stock on the farm in 1884 (and there has been no account of it since, that we are aware of) consisted of 27 head of Ayrshires, 3 grade cows, 2 yoke of steers, 1 yoke of cattle, 1 fine Guernsey bull (a gift of W. A. Reed of Hadley), 1 Ayrshire bull (presented by Benj. P. Ware of Marblehead), 3 horses, 20 Berkshire swine, etc., and 75 fowls.

At the present time the herd of cattle consists of 42 head, all told, as follows: 21 milch cows, 1 yoke of oxen, 1 three-year-old bull, 1 yearling bull, 6 yearling steers, 11 yearling heifers. There are 2 horses, 6 swine, and 16 fowls. The

neat stock are of the Ayrshire breed, with some grades. Only 6 cows that are recorded and old at that.

The help employed for wages are four men on the farm proper and as many more in the Botanic Department.

There is still a great chance for improvement on the farm, but it will have to be done gradually. The soil is particularly adapted to grass, and the farm might be made one of the best stock farms in the State if it could be made profitable. The milk is now sold to the Amherst Creamery. The treasurer's forthcoming report will show the farm account, and the cash balance, if any. We are inclined to think, however, that although the farm has been indispensable to the college for experimental purposes, and as a means of affording practical illustrations to the students, it never has been profitable, as an investment, in dollars and cents.

Roads, Walks, Trees and Shrubs.

Within the limits of the college grounds there are about two and a half miles of roads regularly laid out and gravelled.

A large amount of labor is required to keep these roads and the borders in good repair, so as to present a neat and pleasant appearance. There are also about one and a half miles of walks to be cared for, winter and summer. There have been also planted on the grounds more than a thousand trees and shrubs. It will be remembered that these grounds are being constantly visited by people from every part of the country, and the reputation of the institution requires that they should be seen in a respectable condition.

New Buildings.

When President Greenough entered upon his duties in September, 1883, it was with an understanding that a house should be furnished by the corporation for him, upon the college grounds. This was begun in August of the same year, and finished in 1884.

For a number of years there has been great need of a suitable building to be used for a chapel and library. The facts having been made known to the legislature in 1884, an appropriation of $25,000 was made to supply the demand.

Stephen C. Earle of Worcester was engaged by the

building committee as architect, and Joseph Beston of Amherst received the contract for the work. It was found to be impossible to construct a building suitable in size and style for the amount appropriated, and the legislature of last winter made another appropriation of $6,000, which was deemed to be sufficient for all purposes. The building, however, is not yet ready for occupancy.

New Dormitory Building.

All rooms on the first floor in the lecture-room wing of the new building, and two rooms in the basement, are devoted to special work in agriculture, and one of these rooms is to be used for an agricultural museum.

Upwards of $2,000 has also been expended by the Professor of Agriculture for apparatus, during the past year. The trustees undoubtedly considered it necessary, and have made no further outlay than was actually required.

The Faculty.

The faculty remains the same as last year, with two exceptions. Lieut. Sage has been detailed from the U. S. Army, as Professor of Military Science and Tactics, in place of Lieut. Bridgman, who has returned to his regiment.

Prof. Wellington, a graduate of the college, who formerly held a responsible position as chemist at Washington, but who has been studying in Germany for the past three years, succeeds Prof. Horace E. Stockbridge.

Value of Property.

An approximate estimate of the value of the real estate may perhaps be made from the amount expended. Up to the present time the college property, including the land for the farm (which is made up of six separate estates), the dormitories and all college buildings, has cost not far from $250,000. We do not propose to give any financial account of the institution, — we leave that for the treasurer; but a few general statements may be of interest to those who are not familiar with its history.

The act of Congress, accepted and agreed to by the Commonwealth, requires that the college fund, from the sale of

public lands, shall be kept in the hands of the State treasurer. This fund amounts to $360,067.40, and is always to be kept in the State treasury. The income of this fund, of course, is likely to vary; but, whatever it amounts to, two-thirds of it is paid over to the treasurer of the college, and one-third to the treasurer of the Massachusetts Institute of Technology, according to the provisions of law, for the purpose of maintaining a School of Industrial Science and the Mechanic Arts. By the gift to the Institute of Technology the Agricultural College is freed from the labor and expense of building up and maintaining a mechanical department.

As an illustration of the variation of the income from the fund, we notice that in 1879 it was $12,000; last year it was $10,265. This is not the only revenue of the college, however. The income from other funds in 1879 was $700, and the income from tuition, room-rents, etc., the same year, was $3,500. We are not advised of the income or expenditures in detail during the past year.

We are able to make the gratifying statement, however, that the college at the present time is out of debt.

Practical Agriculture.

The instruction in agriculture and horticulture is intended to be both theoretical and practical, according to the terms of the original act for the endowment of the college. It is the opinion of your committee, however, that the instruction at the present time is more theoretical than practical.

The president has frequently requested the instructors in agriculture to give instruction in field work *in the field*, whenever such instruction is profitable for the students, and the schedules for class exercises are arranged as far as possible to accommodate the professors in agriculture and horticulture in this respect; but if we are not misinformed, field-work is not practised by any system whatever.

In 1867, after the first term of the college had expired, Prof. Levi Stockbridge (the Professor in Agriculture) gave a lecture before the Board of Agriculture, in which he made these remarks: —

"The plan was adopted, upon opening the college, that every young man should work upon the land six hours in a week; that the whole class should work upon the land as a part of their regular school education — two hours on Monday, two on Wednesday, and two on Friday; and then we held out the inducement that we would give them wages for such labor as they could perform without detriment to their studies. The consequence has been that we have had some twenty students that have been at work during the entire term for wages. There has been no trouble about it. It has come as a matter of course. Having established the system, it has worked like a charm. Of course, in these hours of labor we are on discipline. It is regular business as much as the inside work of the college. Now, I have put these boys upon the hardest work. I have made no selection. They have husked all our corn — 1,800 bushels; dug all our potatoes and all our root crops, and spread all the manure. They have dug up five acres of old apple trees, root and branch, and nine acres of bushes were grubbed up by the roots; and they did it all with an apparent pleasure. The plan is a perfect success."

In 1883, President Chadbourne, in remarks upon the college, said upon this subject: —

"The instruction in agriculture and horticulture includes every branch of farming and gardening which is practised in Massachusetts, and is both theoretical and practical. Each topic is discussed thoroughly in the lecture-room, and again in the plant-house or field, where every student is obliged to labor, under the direction of the professor, when suitable work can be done on the farm gardens and nurseries. The amount required, however, is six hours per week, in order that it may not interfere with study."

If this can be said with truth now, we have not been rightly informed. The terms of the act of endowment cannot be construed to have intended this to be merely a manual-labor school, but nevertheless it does mean that practical agriculture shall be taught.

Change Recommended in Examination of Graduating Class for Grinnell Prizes.

The time allotted to the examination of the graduating class for the Grinnell prizes this year was rather limited. When Prof. Miles had finished that part of the examination

which he desired to conduct, the time was entirely consumed, so that there was no opportunity for the committee to further examine the class, either upon the subjects already begun by the professor or any other.

Now, as this is an *Agricultural* College, the examination of the graduating class in agriculture should be more prominent and more time allotted to it. Instead of repeating the programme of the past, we would recommend for next year that each of the graduates, in addition to the oral examination, prepare an essay on some practical subject, — and, if possible, each one have a separate subject, — of not more than three pages, to be read by the writer at the examination, to be followed by questions by the committee, if they have any to ask. This will save time, and will allow each pupil to express his ideas upon any topic he may select, and will also give the committee an opportunity to test the knowledge of each one upon the subject of his essay.

By the present plan the committee have no opportunity to ask any questions suggested by reading the essay. If the examination is to be a practical test of the pupil's knowledge, and the committee are to award the prizes intelligently, some course other than the present should be adopted. President Greenough expresses his views upon this subject as follows: —

"The examination of the graduating class for the Grinnell prizes should be arranged to give ample time, and also, if possible, to meet the plans of the committee. The matter is in their hands, and it is the duty of the President and the Professor of Agriculture to accord to their wishes; and hereafter, if the plan meets the approbation of this board, the time for examination of the graduating class may be arranged to suit the wishes of your committee."

The institution has experienced many discouragements, such as are inevitable incidents in establishing a new enterprise; and while struggling to maintain its existence, and, at the same time, to correct the mistakes which experience revealed and regain the ground thus lost, it has been continually exposed to a galling fire of ridicule and sarcasm from its enemies, some of whom, we are sorry to say, have been

and are in positions of influence, and always pretending to be its friends. But the brightening skies of the past year or two give promise of the dawn of a brighter day for the college, — the entering upon an era of prosperity and usefulness which will reward the faith and perseverance of its founders and early friends, and send forth from year to year bands of young men, thoroughly educated and equipped in the elements of practical as well as scientific agriculture, and who shall be prepared to demonstrate the advantages of such an education as this institution affords. We are glad to notice indications of progress resulting from the operation of the statute, which, none too soon, put an end to the obnoxious self-perpetuating features of the Board of Trustees, and we hope that this progressive spirit will become manifest in a more practical and less theoretical system of instruction in the immediate future.

President Greenough, in reply to an inquiry of your committee in relation to the present encouragements of the college, says: —

"The encouragements are —

1. The quality and character of the young men now in attendance.
2. The excellent rooms now furnished.
3. Increasing facilities for instruction.
4. The earnest and faithful men composing the faculty."

Your committee are unanimous and enthusiastic in the assertion that the Massachusetts Agricultural College is most abundantly worthy of the patronage and confidence of the farmers of the Commonwealth.

A. C. VARNUM,
J. BUDDINGTON.

REPORT OF THE CATTLE COMMISSIONERS

FOR THE

LAST QUARTER OF THE CURRENT YEAR, ENDING JAN. 1, 1886.

To the Legislature of the Commonwealth of Massachusetts:

By act of the legislature of 1885, passed June 19, it was made the duty of His Excellency the Governor to appoint a board of three Cattle Commissioners, to serve, one for a term of three years, one for a term of two years, and one for a term of one year. In compliance with this duty His Excellency appointed Levi Stockbridge of Amherst for the first named term, A. W. Cheever of Dedham for the second, and John F. Winchester of Lawrence, for the third term; and we assumed the duties of the office the 5th of October. The Board of Commissioners on Contagious Diseases among Domestic Animals kindly gave us all the information to enable us to commence our labors promptly and intelligently. We found no prevailing contagion in the State but hog cholera, and many cases which were under the watch of the retiring Board, or where the accounts of losses and expenses had not been closed, came under our control. We found the disease prevailing most extensively in the four western counties, especially Hampden and Berkshire, which fact continues to the present time; but we have received notice of its presence in several towns or cities in Worcester and the counties east. In our efforts to suppress the contagion we pursued the detailed method adopted by our predecessors, which enabled us to confine the disease to the premises where it apparently originated; but we also directed our attention to the source of the origin of each case. We soon became satisfied that every outbreak was independent of all others

in the State, and the result of the use of western pork containing the germ of the disease. As the late Board will doubtless give in their report a detailed statement of this phase of the subject it is needless that we pursue it further. We have been notified by the proper officers of many sick and ailing swine where cholera was not present, and for the reason that their owners entertained the erroneous opinion, that, if the Commissioners were called, their sick and even dead animals would be paid for; but we have found 51 cases of true hog cholera, in premises where 1,595 swine were kept. If this disease shall continue to make its appearance in the singular manner as herein stated, it may be found wise to modify the law, so that appraisal and payment shall not primarily take the form of a bounty to citizens for their sick or dead swine, or that the Commissioners issue a circular to the municipal officers of the State, instructing them that in cases where swine owners procure city, boarding-house and hotel swill as food for their swine, or use western pork in their families, the refuse of which is given them, it must be done at their own risk; and, if such herds are infected with the contagion, strict isolation must be enjoined, but no appraisal or payment for loss may be made.

Horses.

Glanders or farcy is yet in the State, and we cannot say it is either on the increase or wane as compared with the last few years. We are, however, satisfied that the enforcement of the law against it keeps it in check, making a certain class of horse traders extremely cautious about preparing such for trade, and then shifting them from man to man about the State, and, whenever possible, disposing of them to innocent and unsuspecting persons. We have reason to believe that when discovered they are often passed back and forth across State lines to avoid State law by concealment; but we have been able to secure and kill three such animals, sequestered here by parties from Connecticut. The number of suspected cases reported to us has been twenty-two, eighteen of which proved to be glandered, and were destroyed.

Neat Stock.

October 15 the selectmen of Greenfield reported a severe and alarming case of sickness in the herd of cattle belonging to Messrs. Rogers and Parsons of that town, the development of which gave indication of contagion. The premises were visited and examined with care, and an autopsy made of a dead animal. Fears had been entertained that the disease was blackleg, and it had some of its characteristic features. But our examinations led to the conclusion that it was a form of anthrax or charbon, induced by the somewhat hurtful food the cattle had received at the barn, and the condition of the fields on which they ranged. Change of feed, pasture and management were recommended; and no more animals were attacked, the sick recovered and the alarm subsided.

LEVI STOCKBRIDGE,
A. W. CHEEVER,
J. F. WINCHESTER, D. V. S.,
Cattle Commissioners.

Boston, Jan. 8, 1886.

1886.

Times for holding Fairs of the Agricultural Societies receiving Bounty from the State of Massachusetts.

SOCIETIES.	TIME.					Year when Fixed.
Amesbury and Salisbury,	5th Tuesday	after	the 1st	Monday	in September,	1883.
Barnstable, . . .	4th Tuesday	"	"	"	"	1879.
Berkshire, . . .	2d Tuesday	"	"	"	"	1884.
Blackstone Valley,* .	4th Tuesday	"	"	"	"	1884.
Bristol, ...	5th Tuesday	"	"	"	"	1884.
Deerfield Valley, . .	2d Thursday	"	"	"	"	1886.
Essex, ...	4th Tuesday	"	"	"	"	1880.
Franklin, ...	4th Thursday	"	"	"	"	1876.
Hampden, . . .	3d Wednesday	"	"	"	"	1885.
Hampden East, . .	2d Tuesday	"	"	"	"	1886.
Hampshire, . . .	3d Thursday	"	"	"	"	1878.
Hampshire, Franklin and Hampden.	5th Wednesday	"	"	"	"	1876.
Highland, . . .	1st Wednesday	"	"	"	"	1884.
Hingham, . . .	4th Tuesday	"	"	"	"	1883.
Hoosac Valley, . .	3d Tuesday	"	"	"	"	1876.
Housatonic, . . .	4th Wednesday	"	"	"	"	1876.
Hillside, ...	4th Tuesday	"	"	"	"	1884.
Marshfield, . . .	2d Wednesday	"	"	"	"	1878.
Martha's Vineyard, .	5th Tuesday	"	"	"	"	1879.
Middlesex, . . .	4th Tuesday	"	"	"	"	1881.
Middlesex North, . .	2d Wednesday	"	"	"	"	1885.
Middlesex South, . .	3d Tuesday	"	"	"	"	1876.
Nantucket, . . .	1st Wednesday	"	"	"	"	1876.
Plymouth, . . .	3d Wednesday	"	"	"	"	1876.
Union, ...	2d Wednesday	"	"	"	"	1886.
Worcester, . . .	3d Thursday	"	"	"	"	1883.
Worcester North, . .	4th Tuesday	"	"	"	"	1876.
Worcester Northwest, .	3d Tuesday	"	"	"	"	1886.
Worcester South, . .	2d Thursday	"	"	"	"	1886.
Worcester West, . .	4th Thursday	"	"	"	"	1876.

* Same date as the old Worcester Southeast Society.

REPORT ON BULLS.

[Extract from Transactions of Hampshire Society.]

The illness of one and the extreme business of another member of the committee appointed by the Society devolved on your chairman the task of obtaining substitutes; and he was fortunate in securing the assistance of two gentlemen of ripe experience, acknowledged judgment, and marked independence of character. This made his task easy and pleasant; and even where his opinion was overruled by his associates, he had the satisfaction of feeling thorough confidence in the integrity of their motives, and a sincere respect for the principles on which their decision was based.

Of the seven entries in this class, six animals were Jerseys, — a tolerably fair criterion of the general estimation in which this breed is held. Of these six, some had authentic certificates of registry in the books of the American Jersey Cattle Club (A. J. C. C.), others were recorded in the American Jersey Herd Book (A. J. H. B.), while the pedigrees of the rest depended on the assertion of their owners, supported by more or less testimony of a more or less vague and unofficial kind.

Fortunately for the committee, the question of the comparative validity of the several pedigrees did not arise, as the two bulls to which the first and second premiums were awarded were indisputably the best animals in the class, and their proofs of pure, indeed aristocratic ancestry, were clear and undeniable. As, however, this question is likely to arise in the future, it may be well for the Society to decide and define what registration or evidence of pedigree shall be necessary to qualify an animal to receive the Society's prem-

iums. Must a bull be registered in the Herd Record of the American Jersey Cattle Club, or is it sufficient if his pedigree is recorded in the American Jersey Herd Book; or may the committee award a premium to an animal on satisfactory proof that he is descended in a direct line from imported stock, or from registered stock, or stock popularly recognized as pure, always supposing the appearance of the animal to bear out his owner's claims? Much may be said both for and against each of these rules, but it seems desirable that the Society should relieve their committees on stock of an irksome responsibility, and remove a fertile cause of dissatisfaction and irritation to exhibitors, by defining clearly the nature and evidence of pedigrees required.

Deferring to the public verdict, which has selected the Jersey as the best bull for the improvement of the stock for the butter dairy, we could not but regret the absence of the stately Shorthorn, the massive Dutch, the plump Devons, the spirited Ayrshires, the useful-looking Guernsey, the neat little Brittannies, and other breeds which have heretofore graced this class at other exhibitions. Except for a yearling Shorthorn, in only ordinary condition, these breeds were conspicuous by their absence; but it was some consolation to those who had known and loved them, to see that Mountain Lad, Colfax, Gen. Lyon, Fourth Highland Chief, William Tell and Upton had not lived and labored in vain. On every side we see their excellences reflected in their daughters, granddaughters, great-granddaughters; and in the capacious chests, well-arched ribs, wide, long loins, broad hips, level rumps, big, well-shaped udders and robust constitutions of these descendants, we recognize the metal which, stamped with the Royal Jersey die, makes a coin that is legal tender wherever butter-making is the chief or even a considerable object of the farmer.

Perhaps it would be well to stop here; but, like the immortal Dogberry, "I do not forget to specify, when time and place serves, that I am an ass;" that, after all I have admitted in favor of the Jerseys, I love them about as much as the California Irishman loves the heathen Chinee. As the successful result of patient and persistent effort to produce an animal adapted to a certain locality and a specific use, I

appreciate and respect them; but as cattle for New England in general, and the Connecticut Valley in particular, I think they are overrated. I recognize their general superiority as butter producers, but I think it is not only possible but desirable to combine this faculty with larger size and better forms and constitutions.

At a Farmers' Institute, some years ago, I was asked what breed of cattle I would select if I could have my choice of them all. I replied that I would take as my model the famous "Duchess, by Daisy bull." A friend soon after took occasion to express his surprise that I should give so decided a preference to the Shorthorns, and it cost me some little pains to explain that, though "Duchess, by Daisy bull," was the ancestress of most of the Shorthorns in existence, she died some five years before the first volume of the English Shorthorn Herd Book was published, and that I admired her because she was worthy to found a breed, and not simply because she belonged to one. As some of my readers may not have heard, or may not remember, her character and history, I will quote from a letter written by Mr. Bates to the "New Farmers' Journal," in November, 1842. He says: "I selected this (the 'Duchess') tribe of Shorthorns as superior to all other cattle, not only as small consumers, but as great growers and quick grazers, with the finest quality of beef. My first 'Duchess' calved at Holton Castle, June 7, 1807. She was kept on grass only, in a pasture with nineteen other cows, and made in butter and milk, for some months, above two guineas per week."

This quotation is copied from the "History of Shorthorns," by Lewis F. Allen, and the editor goes on to say: "Not knowing the prices of either milk by the gallon or butter by the pound, at that time, a statement of the quantity of each which the cow made would be more satisfactory to readers of the present day."

This is a self-evident proposition, and turning to the "History of Improved Shorthorn Cattle," by Thomas Bell, published just before Mr. Allen's book, we find the following interesting and exhaustive explanation. Mr. Bell says: "Mr. Wastell had a cow called Barforth that gave eighteen quarts of milk at each milking, and made sixteen pounds of

butter per week of twenty-four ounces to the pound. Mr. Bates never had a cow that gave, to his knowledge, more than fourteen quarts to a milking. His first 'Duchess, by Daisy bull,' gave that quantity, and each quart, when set up and churned separately, gave one and a half ounces, or twenty-one ounces per milking. The butter was made up for Newcastle market in half-pounds of ten and a half ounces each, and was sold at one shilling per half-pound. The milk after being creamed was sold to the laborers at a penny per quart, which makes, at twenty-eight quarts per day, 16*s.* 4*d.* per week, and taking off 2*s.* for the diminution of the cream, and fourteen pounds of butter per week at 2*s.* per pound, making 28*s.*, this, added to the old milk value, makes better than two guineas per week."

Translated into plain United States, this means that she gave 28 beer quarts of milk a day, from which was made 294 oz., or 18 lbs. 6 oz. of butter per week. This butter was sold for $6.72 and the skim milk for $3.44, making together, $10.16 per week. Mr. Bell goes on to say, "This she did for some time in the summer, having calved the 7th of June, 1807. She pastured with nineteen other cows, and was kept in the same way in every respect, getting no hand food whatever." And Mr. Allen adds, "At seventeen years of age, having done breeding, she was fed off and made an excellent carcass of beef. She was a great milker."

This record is not very wonderful alongside of Bomba, 21 lbs. and 11½ oz., Mary Ann of St. Lamberts, 36 lbs. and 12 oz., and Princess 2d, 46 lbs. and 12½ oz., but these cows were confessedly fed all they would eat of the most concentrated food; and two out of the three have died in their prime, presumably because their milking capacity was developed and stimulated beyond the limit of their constitutional strength. It has also been suggested by skeptical people that the owners' gift of embellishing may have grown in at least an equal ratio with the butter-making capacity of the cows. But, be this as it may, I have recalled the history of "Duchess" to show that the butter-producing faculty is not only incompatible with good size and admirable symmetry, but that it is found in a high degree and is most permanently and practically useful when combined with the most perfect

development of form and physical constitution. I also wish to call attention to the fact that the particular excellence of "Duchess, by Daisy bull," as well as the general superiority of the tribe and the breed, had been achieved by close study and care in breeding animals for practical value as profitable producers of milk and butter and beef; and that while due importance was attached to pedigree, each breeder used his own judgment as to the value of an animal or a family for his purpose. There were then no herd books, and farmers were not tempted to use an inferior animal because he was recorded, or to reject a superior one because he was not.

Few have more respect than I have for the different herd books as books of reference; like other agricultural text books they are liable to mislead but the neophyte who rushes confidently into paths which the more experienced tread with caution and misgiving. Mr. Bates ably remarks, "The value of pedigree depends not upon the length of such pedigree, but on the length of time there has been a succession of the best blood, without any inferior blood intervening in such succession." "This can only be known by those who have known all the various crosses there are in any animal, and the blood or breeding of such from their own knowledge of the tribes from which they came, and how that produce bred again." Mr. Bates was an intelligent, careful, experienced and eminently successful breeder. Let us see how his teachings and practice bear on the question of breeding at the present day.

The Massachusetts State Board of Agriculture has forbidden the encouragement by the Societies of grade bulls, and has done its best to discourage their use by the farmers of the State. Now, suppose two farmers in the Valley, who each own a herd of good, useful, dairy cows, want to breed a lot of calves to grow up into cows for butter making and finally for profitable conversion into beef. One of them loyally accepts the dictum of the Board, "Never breed from a grade bull," and at some cost and inconvenience sets out to provide himself with a thoroughbred. The Board only stipulates that the bull shall be thoroughbred, but putting aside the temptation to take the first that offers, our farmer is determined to proceed cautiously and intelligently in quest

of an animal suited to his purpose. His first consideration will be to select from a good milking breed, but even in this there is no general rule that can be absolutely depended on. In the grazing breeds are numerous individuals and families with superior milking capacity, and in the so-called milking breeds there are still more which are deficient in this respect. Let us suppose, however, that our loyal farmer decides on some one breed, as best suited to his purpose and circumstances, and secures a bull calf from a heifer with a satisfactory milking capacity. Fed and treated as a well-bred and expensive animal should be, the calf thrives and flourishes, and the loyal farmer thinks he has got a prize, and perhaps he has, but at any rate he must take his chance again and again. And sometime he will make a mistake, and what then? His heifers as they come into milk will sicken and die of tubercular consumption, or his cows will develop a tendency to abortion, milk fever or apoplexy; the milk will be deficient in quantity or quality, or both; and then the farmer will show his bull's pedigree to some one who knows the breed, and he will be told that his misfortunes are not accidental, but the inevitable result of breeding from ancestors known to the initiated to be defective or worthless.

The other farmer has bred Plymouth Rocks and Wyandottes, and knows the possibility as well as the difficulty of combining desirable properties and breeding out defects. He believes that he has got about the class of cattle that suits him, but as there are degrees of merit, he raises a bull calf from the best cow in his own or his neighbor's herd. He has confidence this calf will not disgrace the mother, as he knows the sire and also the two grandsires and granddams of the calf; and he also knows the kind of stock which for several generations the bulls of this family have begotten on different classes of cows. It is an affliction to him that he cannot exhibit his bull or his herd at the Society's Fair, but the Society suffers with him; and he thinks he has more assurance of satisfaction than if he had depended on the herd book, of which he knows practically nothing at all, and the interested representations of breeders whose stock (or at least a good deal of it) is bred, like the celebrated razors were made, not for use but for sale.

I make these remarks with much diffidence, as I have the highest possible respect for the Board of Agriculture, and for many years fully approved the policy of discouraging the use of grade bulls; but observation and experience have led me to change my views, and, having often expressed these opinions in private conversation, I have thought proper to present them for the consideration of the Society. I have written this hurriedly, amid constant interruption and distractions, and I feel that I have not done justice to my subject. I will therefore quote the terse conclusions of an eminent thinker and writer published nearly thirty years ago:

"If all would begin to-day to use what skill and judgment they have, or can acquire, in breeding only from the best of such as they have, coupling with reference to their peculiarities, and consigning to the butcher as fast as possible every inferior animal, and if, in addition, they would do what is equally necessary, namely, improve their general treatment as much as lies in their power, there would result an immediate, a marked, and a steadily progressive improvement in stock. To the acclimation or Americanization already acquired, would be added increased symmetry of form and greater value in many other respects. This is within the power of every man, and whatever else he may be obliged to leave undone, for want of ability, none should be content to fall short of this."

To all of which I earnestly and respectfully respond "Amen."

JOHN C. DILLON.

P. S. Since writing the foregoing, I have read in the report of the Secretary of the Massachusetts Board of Agriculture for 1885, a paper on "Shorthorned Cattle in Massachusetts," by William P. Sessions of Hampden, in which the merits of the pure and grade Shorthorn of the present, as well as of former days, are very ably and truthfully presented. Every member of this Society is entitled to a copy of the report, and will find it interesting and instructive reading.

BUTTER.

[Extract from Transactions of the Worcester West Society.]

The committee appointed to examine the specimens of butter presented for competition at the fair of the Worcester County West Agricultural Society the present autumn, found five parcels, all of which were good, but they experienced no difficulty in arriving at a unanimous decision as to the best three which should receive the premiums offered. The results of that decision have already been published, and will also be found in their appropriate place in the Society's "Transactions."

We suppose, however, that it will be expected that some observations will be offered in this connection, in regard to butter-making, but we realize how difficult it is to say anything new upon this subject, — to offer any suggestions which have not already been set forth, perhaps in a more attractive form, by some one else. The care of the milk while the cream is being raised, the temperature, the churning, the salting, the final manipulation which prepares it for the table or the market, the importance of perfect cleanliness, and preventing contact with foul odors, — these and other things which the butter-maker cannot safely neglect, have often been repeated, and yet it seems that there is still need of "line upon line, and precept upon precept," for not every one has yet learned (or if they have learned they do not practice as well as they know) that constant vigilance, from the feeding of the cows to the marketing of the butter, is indispensable to the highest success. If any one is inclined to be skeptical upon this point let him look at the assortment

of butter in the refrigerator of a country store, and he will be likely to notice the want of uniformity in appearance,— not to speak of the diversity in quality of the different parcels. These remarks are pertinent to the case in hand, because most of the butter offered at our fairs is the product of private dairies. Butter that is produced in modern creameries, where large quantities are made, for reasons that will be apparent to all, possesses a uniformity in flavor and consistency, as well as in color and appearance, which is very desirable, and which is somewhat difficult of attainment in small dairies, where the churning is done perhaps not oftener than once a week. In a well-ordered creamery the machinery and appliances are such that the variations in weather and temperature are substantially overcome, the large quantities of cream produced rendering it possible to have an entire churning of the same age. The salting, working and packing are also subject to a uniform rule or system, all of which tend to a uniformity in quality and appearance, which is appreciated in the market; and a grocer who once becomes satisfied with the product of a certain establishment, feels safe in sending the same to his customers, for it is to him a standard article as to all desirable qualities, as much so as a certain brand of flour or sugar.

It is not in our province to decide upon the merits of any of the patent devices for separating the cream from the milk, —whether it be done by deep setting in submerged cans, or in shallow vessels with air-tight covers, or by centrifugal force,—each of which methods has plenty of enthusiastic advocates. And while it must be admitted that there are dairy-women in this community whose butter, made by the old-fashioned process, reaches a high degree of uniformity and excellence, it is equally true that the vast majority of those who follow the old method produce an inferior article, and "it goes without saying" that most of the latter class would not be likely to improve the quality of their butter very much were they to adopt any of the more modern methods, since no patent contrivance can possibly compensate for lack of care and cleanliness in the manufacture of butter.

Reference has already been made to the importance of great care during the entire process of manufacture, but this is not all that is required, for very much depends upon the manner in which the product is put up or packed. And while we would not intimate that inferior butter may be rendered passable by extra care in the finishing process, we are prepared to assert that much excellent butter has been spoiled in the working and packing. We all know the potency of a first impression. Comparatively few consumers of butter are blind, and a still smaller number eat with closed eyes. If the article has not proved attractive to the eye, there is great danger that the palate will be biased in its decision, — if, indeed, the test be allowed to proceed so far. Hence we say, attractiveness in outward appearance is of primal importance. And so it happens that in the examination of butter the test begins where the process of preparation ends. After the article has passed inspection by the eye it is brought to the test by the other senses; but if the seeing has not been pleased there is danger that other senses may be prejudiced.

Much butter originally excellent has been ruined by too much salt or too much working. The quantity of salt should not be sufficient to obscure the fine flavor always present in good butter. But the diversity of tastes of consumers and the length of time the butter is to be kept must determine, to a certain extent, the question of quantity. But we know of no advantage to be gained by working the butter so much as to destroy the grain and impart to it somewhat of the consistency of lard, as is very often done. This over-working is doubtless due, in most cases, to a commendable desire to expel all the buttermilk; but if the butter is firm, — as it should be when the temperature and other conditions are right, — there will be no difficulty from the undue presence of buttermilk.

We regret that so little interest is manifested in this department of the Society's fairs on the part of contributors, but we take pleasure in being able to notice that all the specimens offered were so good. It would certainly seem that at an exhibition which included four hundred and fifty

head of neat cattle, nearly all of which were milking stock, one might with reason expect to find more than five lots of butter presented in competition for premiums; and yet such was the history of our late fair. Let us hope that history will not repeat itself in regard to the item last referred to.

J. Henry Goddard.

Barre, Nov. 20, 1885.

ANNUAL ADDRESS AT HOOSAC VALLEY FAIR.

DELIVERED BY HON. HENRY L. DAWES, WEDNESDAY, SEPT. 23, 1885.

The present is more than an annual festival with this Society; it measures an epoch of twenty-five years since its organization. The retrospect suggested by this event cannot fail to furnish to its founders and patrons abundant satisfaction and reward for all past outlay and labor, and encouragement for redoubled effôrt in the future. The contrast between the ample grounds and spacious quarters which now accommodate and attract the crowds that enjoy your festivities and profit by your exhibits, and the meagre and feeble beginnings of that day, is equally striking and instructive. The most ardent and enthusiastic devotee to the pursuit of the agriculturist in this Commonwealth could hardly ask for stronger evidence of the growing interest and augmented results which are crowning his labors, than is furnished by a survey of these twenty-five years. In the first twenty years of this period the number of farms in Massachusetts had increased 2,850, and in Berkshire alone 657. The cash value of farms has in that time also increased; in Berkshire $2,782,688, and in the State $23,000,000. The number of acres improved had in Berkshire increased 14,135, and the annual market production $300,000. The annual product of hay had increased in this county 19,899 tons. Berkshire has in this period added 2,000 to the number of her horses and the State 13,000, and in quality and value more than 50 per cent. Of milch cows the number in the county has increased 1,509, and in the State 6,000; but the improvement in the breed and quality of cows, in that time,

has been so marked that their value is now estimated to be five times what it was when this Society was founded. While in some articles of produce, like wheat and wool, there has been a falling off of value in production, yet, in the aggregate, the products of Massachusetts farms have increased in the same ratio with the increase in the value of the farms themselves, which, as has been seen, was in 1880, $23,000,000. To all these figures must be added the increase of the last five years, which, in the same ratio, would add one-quarter to them all. These figures are not large, it is true, and compared with the great returns from the vast grain fields and cattle ranges of the West seem insignificant, yet they are more than sufficient to meet the charge that our farming interest is declining. There are other evidences of thrift and prosperity in the homes and lives of New England farmers which figures take no note of, but which are the same outcome of increasing means, of a stronger heart, of a greater faith in their opportunities and possibilities. Their homes have been filled with comforts and conveniences, and beautified and adorned with a taste to which the farmer's home of fifty and even twenty-five years ago was a stranger. A neatness and elegance, and even luxury, all along the valleys and among the hills of New England, are drawing the city life away from the fashionable watering-places to the quiet farming country for its summer recreation. The outside as well as the inside of the farmer's home gives evidence of a healthier life. Fruit trees and vines and flowers are only a little way behind the fertilizer, the mowing machine, the horse rake, the reaper and the tedder, and are, with these, his helpers to a higher and better realization for his labor than was ever enjoyed by those who have gone before him. The farmers of Massachusetts have invested, of their earnings over and above their own support, more than a million and a half of dollars, and those of Berkshire County alone only a little, if any, short of one hundred thousand, since the organization of this Society, in such agricultural instruments and machinery as prove substitutes of their own manual labor before that date. Better than all, the farmer himself is stronger. His increasing income has enabled him to make larger expenditures in the acquisition of that know-

ledge which makes its possessor a power among his fellow-men. The sons and daughters of the farmers of Berkshire, and the Commonwealth, in general and useful knowledge, and even in higher education and accomplishments, stand proudly in the first rank. In our public schools, in our higher seminaries and colleges, both for men and women (the latter of which had no existence twenty-five years ago), they win their way to the highest rank and fit themselves for the broadest and largest influence in the world.

In this period we have been considering, more than 100,000 volumes have been put into public libraries, for the free use of the public in Berkshire alone, and the newspapers and other periodicals read by her people have increased a hundredfold. And so it has been throughout the Commonwealth. And all this time our farmers have made their struggles with adverse conditions of climate and soil, a very nursery of men and women for other fields of labor. The world owes more to Massachusetts for the surplus of the sons and daughters of these hillsides, who have been sent forth into the conflicts and competitions, and have shown their mettle and brain in every field of enterprise, and the sterling qualities of their character in all noble effort where force and worth measure merit, than it does for all else it has gathered off her soil or people. These are the exports in which our farmers have their chief pride. Every year adds to the number thus sent forth, with Massachusetts instincts, principles and training, to add to the wealth and force of the communities which receive them, and that too without impoverishing the mother which spares them. Massachusetts will always be rich, while she can hold herself even with the foremost and still send her life-blood coursing through the veins of all progress and achievement throughout her sister States.

I have taken this brief survey of the twenty-five years since the organization of this society for a double purpose. It is worth while, after so many years of diligent endeavor to improve the condition of the farmer's life in this Commonwealth and augment the rewards of his labor, to look back and see what are the evidences that the effort has not been in vain, and to answer the question, as I think I have

done, whether farming in Massachusetts has ceased to be profitable. The soil of this goodly State of ours never yielded such abundant returns to the husbandman as now, nor were his prospects for the future ever brighter.

Let the croaker cease his grumbling, and the discouraged rise earlier in the morning and put a little more pressure on the beam of his plough, and the harvest song will gladden his heart.

But I had another object in view. It would be well for the farmer to know to what he may attribute this well-assured prosperity, and where he is to look for its continuance. It is its lesson I desire to enforce. I was invited to address this Society at one of its first, if it is not its very first fair, twenty-five years ago. I then endeavored to show the need of practical and experimental agricultural education to the farmer of this Commonwealth. To-day I would impress upon him the need of building up his market. From the education thus urged he has without doubt derived great benefit. He understands better the nature of his soils and their adaptation to particular crops, as well as better methods of fertilization and cultivation. And in all ways this education has made him more sure of his crop and more certain of its abundance. To that extent this education has been his helper, and it never must be disparaged or abated.

But this would have availed him little, beyond the supply of his own table, if his market had failed him. Without that he could have added nothing to the stock on hand in the beginning, and the condition of things, spite of better cultivation and more abundant harvest, would have been now precisely what it was twenty-five years ago. It is what he sells which enables the farmer to buy new farming implements, improve his breeds of stock, paint and beautify his house and grounds, and educate his children. It is on his gains alone, beyond what he and his consume, that he rises in the scale, or adds one cubit to his stature. And his gains come alone from what he sells, and he cannot sell without a market. It hardly need be added that the better the market the better will be his sales. Beyond the effect of agricultural education, already spoken of, the reason why the Massachusetts farmer is better off to-day than twenty-five years

ago is because his market is better. The farmer's business is to feed those who consume but do not produce agricultural products. The proposition is stated in this way, which makes it perfectly clear. The farmer feeds all, but when all are farmers he only feeds himself. The farmer in Massachusetts, therefore, must find some one who is not a farmer to sell his produce to or he cannot sell it.

One other condition of this proposition is equally clear; he must find that purchaser close at home, for he cannot add the freight to the cost of production and then sell as cheaply as the Western farmer who can raise the same crops at half the cost to him. The cost to him and the freight together makes his produce so dear that he cannot sell it in the same market with a Western competitor. Now we are prepared to understand why the farmers of Berkshire, and of the whole Commonwealth as well, are better off to-day than they were twenty-five years ago, when this Society was formed. Those who consume but do not produce agricultural products have been multiplied all around them. Take the old town of Adams, where this Society is situated, as an illustration. There were in this old town, when this Society was organized, 6,877 inhabitants; there are to-day, in the same area, not less than 20,000 residents, and this entire increase has been in the manufacturing employments in the old town of men who must buy all they consume, and the farmer has by just so much a larger and better market for all he can raise. This is why he has produced more, because he could sell more at his own door. And this is what has added $3,000,000 to the value of the farms in Berkshire, and more than $23,000,000 to those of the State. The census, that great revelator of the sources of wealth and strength in this nation, discloses that just where these centres of manufacturing and other non-agricultural producing population exist, there the real estate of the farmer is most valuable, and his condition most prosperous.

In Massachusetts the value of the land in the non-manufacturing counties is only three-fifths as much as in the manufacturing counties, in Connecticut only three-sevenths as much, in New York only half as much, in Pennsylvania less than one-half, and in Delaware only two-sevenths as

much. In North Carolina, a State as old as Massachusetts, with a warmer climate and a richer soil, but without manufactures or any considerable number of non-agricultural producing people, the value of the farm lands is only one-seventh that of the farm lands in Massachusetts. There is a single undeveloped water power on the Roanoke River in North Carolina, superior, in every respect, to that which to-day furnishes employment for twenty-five thousand people at Holyoke and forty thousand at Lawrence and sixty thousand at Lowell, none of whom produce but all of whom consume everything which can be raised about them. The two counties of that State between which that river flows, and which lie on either side of that magnificent water power, are capable, each of them, of producing eighteen thousand bales of cotton a year which could be worked up in sight of where it grows. And yet, because there is nobody there to buy and consume what the farmer can raise, all the land which borders and commands that water power can be purchased for less than five dollars an acre, and the solitude of the primeval forest is unbroken because nobody can be found to pay fifteen cents a cord for the wood. Put a Lowell there, as God intended there should be when he sent that great river over so wonderful a fall, and let the music of its machinery and the busy fingers of its manifold industries fill the air with a new song, while its returning life is incessantly calling for food, and all land that could be planted and tilled would be worth a hundred dollars an acre for farming purposes alone. A gold mine is not worth so much to the miner as such a market to the farmer.

A new industry that has sprung up in this country in the last ten years, illustrates the truth I am trying to enforce so clearly that the lesson cannot go unheeded. Ten years ago it was proposed in Congress to abandon all further effort to induce the manufacture of silk goods in this country. The proposition failed, and that industry has since become a very prosperous business. The census of 1880 disclosed that this new industry had the year before manufactured $41,032,045 worth of goods in this country, employing 34,529 hands and paying them in that year $9,146,705 in wages. Let us see how much of a stake the farmer has in that single enterprise.

The 34,529 hands employed would make a good deal of a city. But every one of those hands must bring along with him at least one other person in the household in which he lives, much more than that number when all the wives and children of the families which furnish 34,000 employees are counted. But one additional consumer at home makes a city of 70,000 consumers demanding to be fed by the producers of food, while they themselves devote their whole time to the production of fabrics. But a city of 70,000 cannot stand alone. Where that is there must be carpenters to build them homes, masons to lay the mortar, nailmakers somewhere to make the nails, cabinet makers to make furniture, somebody to make cloth, to cut and fit it, shoemakers, hatters, blacksmiths. None can tell where the list will end of consumers of the products of the soil that this single industry, new to this country, gathers around it. If the manufacture of silk had been concentrated ten years ago in the Hoosac Valley, and it might as well have been here as located where it is, every foot of farming lands in the limits of this Society would have been enhanced in value fourfold. If any one doubt the influence in this direction, upon the fortunes of the farmer, of the presence in our midst of the large class of consumers engaged in other pursuits, let him conceive it possible, without harm or convulsion, to withdraw them all, and leave the entire domain to the farmer alone. He would be as worthy a citizen in every respect as he is now, as industrious, as frugal, as intelligent. The seasons would be as propitious and the soil as kind as ever. But if he raises a bushel or a pound more than he or his consume, it must perish on his hands, for distant markets are supplied by those who can raise more abundantly and cheaper than he, and who can pay freights and still undersell the actual cost to him. There can be no future for a farmer under such conditions here, and he must leave also, and give over these beautiful hills and fair valleys to the solitude of a wilderness, when he fails to find by his side those who will consume his surplus.

It may be said that the farmer here at home is already obtaining from his soil nearly the full limit of production, and that any considerable increase in the number of those

devoted to other employments must depend for support upon the more fertile grain fields of the West. This is a mistake. There is nothing which can be produced in our climate that the farmer will not find a way to produce, if he can also find a customer to buy it. Doubtless methods of farming would undergo changes to meet new demands. Already, these changes have come to the farmers about Boston. The great increase in population in and about that city has built railroads radiating in every direction into the country, and the farmers, for twenty and thirty miles around, can supply the market of that city every morning with whatever can be raised upon our soil. The result is that market gardening is the prevailing husbandry of the farmers in the vicinity of that city. All the fruits and vegetables of a perishable nature are thus daily turned to a profit, and nothing is lost. And the demand tempts the tiller of the soil into every possible variety of culture, till he becomes the caterer to all tastes and the purveyor for all appetites. The city in turn furnishes him with more abundant fertilizers, and thus the greater the demand the more abundant the means and facilities for meeting it. And so it would be around any centre where diversified industries may gather non-producers of agricultural products in large numbers, who are sure to make a market to be supplied with whatever the farmer can furnish.

The New England farmer, availing himself of all the benefits to be derived from agricultural education and experiment, must still rely for permanent prosperity upon a market at his own door, furnished by those who consume but do not produce what he has to sell. Bounties are but temporary expedients. Opportunities are highways he can travel if he will till he reaches better conditions and surer rewards. Bounties only boost the feeble. By opportunities men climb of their own strength and grow stronger in the effort. Let the tiller of the soil have the opportunity which the manufactory, the workshop and the furnace will give him, crowd these valleys and these hillsides with the homes of artisans and operatives, fill the air with the music of the spindle and the loom, and then you will crowd also the streets of your towns with the market wagons of a prosperous husbandry.

I have spoken for the Berkshire and Massachusetts farmer,

but what I have said outlines the true national as well as State policy. The home market is the true market for the western farmer as well as the eastern. The census tells us that we raised in this country in a single year farm products to the value of $2,212,540,992, and that with this we fed our own people and exported in that year a surplus of $177,003,-274. On all this enormous amount some one has lost the freight to the foreign market, has lost also the insurance against perils of the voyage, the pay of the middlemen who handled it, and the interest of the money for the time he has been awaiting returns from sales in foreign markets. And when it was sold the price, not only of that exported, but of the much greater part consumed at home, was determined by the supply of foreign producers and the greater uncertainty of peace or war in Europe. All this would be avoided if a Birmingham planted at St. Anthony's Falls, a Manchester at Cincinnati, and a Leeds at Rock Island, would consume at the gates of the western grain fields the products now sent abroad at so great a cost. From sheer inability to find anybody to consume, farmers on the prairies have frequently burned their corn as fuel. That national policy which should require that everything manufactured for us, and that the labor performed for Americans should be performed in America, would build up these cities here, and open here the market for all we produce. The permanent prosperity of the farmers, therefore, West as well as East, depends upon the multiplication of diversified labor in our midst, and upon the protecting and fostering care which the nation shall extend to the American laborer in the infinite variety of pursuits to which his genius and enterprise shall invite him.

The farmer and the manufacturer, the representatives in this country of two great divisions of human industry, the workers who produce and the workers who only consume the products of the soil, are so mutually dependent upon each other that they must stand or fall together. The one cannot rise on the back of the other. The farmer cannot prosper without a home market. He cannot have it if what is manufactured for us is manufactured abroad. The manufactures which we consume cannot be made here without

multiplying the consumers of food and the building of a market for the farmer at his own door; thus it is that fair weather and foul are alike for both.

They must walk together in the paths of prosperity or adversity. No governmental policy can build up the one which leaves the other to languish. Whatever, outside of himself, lifts the one, will be found elevating the other. Neither can say to the other, "I have no need of thee." A common prosperity and a common destiny await both. They stand as the pillars of the state supporting the whole superstructure. All others live off the 12,000,000 of producers represented by the farmer and the manufacturer. These feed and furnish almost the entire 43,000,000 who constitute the rest of our people, and their failure would work the ruin of the state. Their claim upon the fostering care of the government is therefore as broad as "the general welfare," for the promotion of which that government was established. It is the claim of the American laborer, in whatever field he toils; and it is his appeal that this field shall be his, his in which to earn his daily bread, his in which to build a home to fit his children for a better lot and himself for citizenship and responsibilities in a common government whose earnest aim shall be to secure to all who live under it every opportunity for work its growth and development can furnish. Thus shall this "common welfare," on which our fathers built, find its own stability and strength in the prosperity and elevation of American labor.

LECTURES

DELIVERED BEFORE THE

HINGHAM AGRICULTURAL AND HORTICULTURAL SOCIETY.

SOCIAL AND POLITICAL LIFE OF THE FARMER.

ALLEN P. SOULE.

The Royal Academy of Paris offered a prize, a few years ago, for the best essay upon the camel. The contestants were an Englishman, a Frenchman, and a German. The Frenchman hastened at once to the Zoölogical Gardens, and in the short space of three hours returned with a rush, waving aloft in his hand an essay, which he had dashed off at the moment's notice, very bright and sparkling, but highly superficial. The German was discovered, after a long search, in a garret, with head embedded in his hands, slowly puffing his pipe, and trying to evolve from his inner consciousness just what a camel ought to be. On looking for the Englishman, he was found packing up his luggage and preparing for a three years' trip to the land of the camel, for the purpose of gaining, by actual observation and experience, an accurate knowledge of the character and habits of the animal.

You will pardon me, gentlemen, if I step aside from the usual course of selecting technical subjects, and take a topic which it will not be presumption in me to discuss, since I have, at least, spent "three years" in acquiring my information, and am also the descendant of a long line of ancestors

who have, from the time they first touched foot upon Plymouth Rock, gained a fair and (so far as I have been able to learn) honest living by tilling the soil. Those noble men who first landed upon the shores of New England, and in their simple manner tilled the soil, possessed knowledge and wisdom sufficient to establish laws and customs which almost three centuries have failed to shake, or even to cause to weaken. That intelligence which they used in making the wilderness blossom, and the earth to yield up its fruits, was the same as that used in making laws, establishing schools, founding cities, and developing the vast natural resources of a great country. By their example, they have shown to us that to be successful in agriculture requires just as much intelligence, skill, perseverance, industry and energy as in any other profession. From time immemorial, the great minds of the world have been devoted to the problems relating to human life, with these objects in view; namely, to ameliorate suffering and *elevate* the human race.

Much thought has been given to the problem relating to the condition of the farm, since the wisest minds have recognized the great influence which agriculture has had in the progress of the civilization of the world. From the time that Plato formed his ideal republic, down through long ages, embracing socialism in all its forms, every scheme for the mutual advancement and amelioration of the hardships of the farmers has failed, simply because the one important element of intelligence has been left out. There is, and always has been, to a large extent, a feeling that the pursuit of agriculture is a menial employment. I am not sure but that a large proportion of those who follow it feel that this is true, and direct their energies accordingly. It will not be out of place just here to consider what influence agriculture has had in the progress of the world, and under what obligation to it those are who follow it to-day. Man has had implanted within him the germ of his own development; he is endowed with faculties, both physical and mental. In order that these may be developed to the greatest extent, it is necessary that they should be subjected to constant and well-directed exercise. Now, just as the seed, which is planted and surrounded by favoring external circumstances, germinates,

grows, buds, blossoms and produces fruit, so man's development has been produced by certain influences, the most important of which is agriculture.

What are some of the great results which have been attained by its pursuit? It has taught him to attach himself to fixed habitations, and to draw his mind away from the useless and barbaric customs which accompany uncivilized life, and seize upon the vast resources of nature, the very elements themselves, and turn them to his own use. As Emerson says: "The farmer had much ill-temper, laziness and shirking to endure from his hand sawyers; until one day he bethought him to put his saw-mill upon the edge of the waterfall, and the river never tires of turning his wheel. I admire, still more than the saw-mill, the skill which, on the seashore, makes the tide drive the wheels, and grind corn, and which thus engages the assistance of the moon, like a fixed hand, to grind and wind and pump and saw and split stone and roll iron."

Thus you see, by using these powers, he has become constantly better acquainted with them, his mind has been stimulated, and, above all things, he has been taught to know himself better.

> "Nature is man's best teacher; she unfolds
> Her treasures to his search, unseals his eye,
> Illumines his mind, and purifies his heart;
> An influence breathes from all the sights and sounds
> Of her existence; she is wisdom's self."

Agriculture has taught man to have respect for right, not only his own, but that of others; for law; and, above all, has made him, both by necessity and for pleasure, a social being. Being under such obligations, can the man who follows this profession neglect to perform those duties which agriculture seems to impose upon him?

The first and most important duty a man has to perform is to keep alive and *improve* his social relations. Nations that have recognized this duty have always been the foremost of the world, and as long as they have kept this in view have made rapid advancement. Greece and Rome never began to decline until after they began to till the soil

by means of slaves and hirelings. When the bonds which held these people to strict and pure social life began to fail, then came the downfall. Cicero recognized the full moral power of the farmer, when he argued for the distribution of the men who had been corrupted by city life among the country towns of Italy. All through the Dark Ages, men lived in a state verging on barbarism; and the first sounds of awakening to a new life came from the country. All modern countries have recognized, at some time or other, the great value of their agricultural population. Here in this country our whole social life rests upon the home, the school, and those organizations which exist to promote the moral and intellectual welfare of man. Where shall we look to find these in all their strength? Not to the great cities, assuredly. "Eternal vigilance," it has been said, "is the price of liberty." As long as the forces which protect our social life are kept intact, our welfare and our liberty are assured; but let them once be destroyed, and we are lost.

Look at England, to-day one of the most powerful nations in the world, putting forth all the statesmanship she possesses to settle the agrarian difficulties in Ireland, to her own advantage. It is the same old story. She finds it impossible to effect a settlement; and I beg to remind you that from the experience of other nations, she will never be able to do so until every man is allowed to own his own rood of ground, and breathe the pure air of heaven as a free man.

I have spoken thus far of the influence which agriculture has had and does have upon civilization, and the *duties* which it imposes upon those following it. I have selected this subject, because farmers, like all other professional men, get together and talk over technical subjects until they become one sided and theoretical; you discuss the best method of planting this crop or that, the most profitable crop to raise, method of preparing the soil, etc., until one would be led to think that this was the chief end and aim of life, instead of a means of living. If, as I have said, agriculture is the foundation of all human progress, and is necessary, not only for the well-being of the State but also for the chief source of happiness of the human race, it is necessary that its standard should be kept high. How shall this be

done? We of New England, being an older section of the country, are called upon to deal with this question first, and there is no doubt but that there is a difficult problem before us. Why is it that the youths of the country are pressing into the city, that the farms are growing smaller and poorer, and each year it becomes more difficult to procure competent farm hands? I think it is not difficult to find the cause. It is due to the idea that has obtained in other countries, and eventually led to their downfall, that farming is a menial employment and fit only for the ignorant and uncultivated.

Now, what is done to counteract this? The young do not leave simply because they cannot make it pay, although, of course, this is an important consideration. There is something beyond this, which cannot be remedied by discussing the best methods of doing certain kinds of work; there is a desire for society, for pleasure, for improvement, and if there is no opportunity for this at home, they will seek it where they can find it. I do not forget that the daily toil upon the farm is hard, that it is wearisome to the limbs, and too often stagnates the mind; but as I recall many men who have made a success of farming, — and when I say success, I do not mean those who have scraped together a few thousand dollars at the expense of body and soul, but those who have lived honest, upright and enjoyable lives, — I know that by well-directed effort, wealth, comfort and happiness can be secured.

I have seen two farmers living side by side, both possessing equal advantages in health, strength, and surrounding circumstances; one was able to surround himself with all the comforts of life, the other was miserable and unhappy. Now, wherein lay the difference? The one directed his energies by a broad intelligence that would have made him successful in any business; the other directed not at all.

I fear lest you may think that I am isolating the farmer and am making impossible demands on him, but I am not. I am simply pleading for the application of the laws and rules which secure success in any business to that of farming. To show you that this is not the case, is it not a frequent remark to hear, when a young man has made a con-

spicuous failure, that he had better "go to farming" or "had better have stuck to farming?"

Now, I protest against this, and hold that the same conditions must be complied with by the farmer as by the merchant, the doctor or the lawyer. The basis of our New England civilization, for which she is noted the world over, is the home. All that we are, all that we can ever hope to be, rests upon the sacredness with which it is preserved and guarded. Let this once be destroyed and our whole social system will fall. Is not the farmer, then, under greater obligations to see to it that it be sacredly guarded? But it would be impossible to do this unless all were properly educated. Then the farmer, no less than other classes, is under obligations to see to it that the training of the home shall be supplemented by that of the school. Yet, how often you hear the remark, that it is not necessary for the farmer to receive training in school, only sufficient to enable him to read and write. How unreasonable! To think that what is good for one man to secure right living is unnecessary for another. When I speak of education, I speak of it in its broadest sense; in a sense in which it ought to be understood by all. I speak of that education which includes all the influences which are brought to bear upon us, the least of which is the technical education of the schools. It is based upon the many-sided, undirected impulses arising from home, companions, books, and contact with the world in all its varied relations. "The expressly appointed schoolmasters and schoolings we get," says Carlyle, "are as nothing compared with the unappointed, incidental and continual ones, whose school hours are all the days and nights of our existence; and whose lessons, noticed or unnoticed, stream in upon us with every breath we draw." Let the farmer see to it that the surroundings are harmonious, that these influences are exerted, and then let him supplement them by the specific education of the school, and his progress is sure.

That this is true can be proved by observation. I am not attempting to lay down anything in theory which cannot be established by innumerable examples. Of many cases I recall to mind one in particular: a man who started out in life without a dollar, yet he was able to raise up a large family,

educate them and surround them with all the comforts of life. They have all adopted the work to which they were trained, and are all honorable, upright and intelligent men and women. Now, in what way did he accomplish this? He made home the best place on earth; by precept and example he taught them that all well-directed labor is honorable; he put into their hands an education which was a means of enjoyment and an aid to their progress, — the school and the college did *not* unfit them for their work; he surrounded them with books, papers, pictures and music, — the result is that they have proved to be able, intelligent, upright men, while his neighbor remains in the same rut to-day that he did in the beginning. To speak of man's duty and obligation to society simply from the standpoint of the relation to home and family, would be to reduce it to a point of selfishness, such as would tend to produce harm and in the end cause its own ruin. He is under obligations to keep alive and encourage those institutions which are organized for the mutual advancement and pleasure of society as a whole. I fear that in this most important matter the farmer is too negligent, from the fact that it imposes upon him a task that calls for a division of his efforts, which, upon the face, appears to him to require a sacrifice. But if men make progress it must be done by united effort. To do this requires organization. You have here, in this town, this Society, which is the best possible evidence of your thrift and prosperity. Here you can meet together and discuss those questions which relate to success in farming, profiting both by the successes and failures of each. Can you not think of some who are to-day struggling along in a half-hearted, half-successful manner, who would be profited by the discussions which take place here in your meetings? There is nothing to prevent societies of this kind being formed in every county and borough in the State, and I know they would be productive of much good, in more ways than one.

I have thus far spoken of social relations in so far as they relate to progress and advancement of the individual, and incidentally, of course, of society as a whole. Based upon our social life, and growing upward and out of it, is our political life. This subject, especially in our own country,

demands our most careful consideration. I am not a party man, and shall endeavor in my discussion to lay aside all party prejudices and treat this part of my subject in a fair and candid manner.

Based, as I have said, upon our social life, political life is the touchstone by which we can test the thoughts, the ideas, the purposes of the life on which it rests. It cannot rise higher, it cannot sink lower, than the average knowledge or belief of the state to which it belongs. Now I do not intend to impose upon the farmer any unnecessary obligation; I do not intend to demand for him any unnecessary consideration; all that I ask of him and for him is that he shall assume and be allowed to take the responsibility which, from the position that he occupies in life, belongs to him. I do not believe in the demagogism of those who cry for hayseed and cowhide boots. In my native State we heard "the tramp of cowhide boots, from Aroostook to the sea," and we saw how mercilessly the wearers of those boots were taken in, and then we heard them tramp back again in hasty retreat. The lesson we learn from this is, that those honest farmers, pressed by the stringency of the times and led by false theories, arrived at a hasty and wrong conclusion. But if they did take a false position hastily, they no less hastily corrected their mistakes when they found them out. But there are real dangers which ought not to be overlooked. Now, in speaking of these, remember that I am not applying principles or rules which are not just as applicable to men in other kinds of business.

Men may grumble just as much as they please, but just as long as they vote for unfit men to make the laws, just so long must they suffer the consequences. See how many questions there are before the country to-day that have a direct bearing upon agriculture! There is the interstate commerce bill; the tariff, in all its varied phases; the treaties which are being negotiated with other countries, — all of which are of vital importance to the farmer. What part does he play in the settlement of these questions? The men who pay seven-eighths of the whole tax of the country have a representation of one-eightieth in the body of law-

makers in the country. Separate the farmer's share from this, and you will see what a small part he plays in making the laws which affect his own interests. The period of past legislation has been constructive; dealing with new questions arising from the introduction of new means of transportation, the settlement of new sections of the country, distribution of the public lands, etc. In dealing with these questions, the settlement has always been against the interests of the farmer.

The trouble arises in this way. When a trade in private life is effected, it is always made between the two parties interested, and is supposed to be for the mutual interest of both. Now, when the matters requiring legislation which affect the farmers are before Congress, the men who are to arbitrate upon them are not interested parties in the sense in which we speak of it in private life. The monopolies are thoroughly organized; they bring to bear the most powerful lobby in the world; the large part of those who settle the question are either actuated by dishonesty or deceived through their ignorance; the consequence is that the interests of the farmers suffer.

If in my discussion I have led any one to think that I wish to magnify the power of the farmer, to attach any undue importance to the profession, or give him any undue advantage, I wish to correct the misunderstanding. All that I claim for him is his share of the power, the responsibilities, the blessings of the country to the prosperity and success of which he has contributed so much.

We are to-day purely an agricultural people, and must remain so for many years. May the day be far off in the centuries beyond when our country shall show signs of weakness, through dangers growing out of corrupt social and political life. May the influence of the "embattled farmers" who gathered on the green at Lexington, — may the influence of those men, who, when the life of the nation was in danger, rushed to its defence, pacing their lonely beat around the nation's capital in the darkness of the night, and marking their line of march with footsteps of blood under the sultry sun of the South, — may their influence go down

through the ages with us, actuating us to nobler impulses and higher motives.

In ancient times, the sacred plough employed
The kings and awful fathers of mankind;
And some, with whom compared your insect tribes
Are but the beings of a summer's day,
Have held the scale of empire, ruled the storm
Of mighty wars, then, with unwearied hand,
Disdaining little delicacies, seized
The plough, and greatly independent lived.

[Extract from Transactions of the Mass. Horticultural Society.]

CHEMISTRY ON THE FARM.

By LOUIS P. NASH.

"Away back in the dim and dusty regions of the past tense," as genial Artemus Ward hath it, when man emerged from barbarism and set out on the glorious march toward civilization, almost his first step was the cultivation of food plants. A savage does not provide for the future; but as soon as a rice patch gave the men of a village the certainty that they would have food enough, then they were encouraged to build better houses; they had leisure to make better furniture; they began to improve; hence the farmers of the community are justly regarded as the corner-stone of society. The earliest farmers planted the seed, or their wives did, and took off the crops, until a field was exhausted; and then they knew nothing better to do than to let that field run waste and clear a new one. But one day appeared a genius, who suggested that something should be put upon the land to repair the loss. "Practical men looked down on the new-fangled notion," but it was tried, and it paid. A good many fertilizers have been used; we learned from the Indians to put fish upon the corn-hills; but as the larger part of farm crops is fed to animals, the most natural manure is the waste derived from the crops themselves. The second epoch in the history of farming was passed; and lo, now, these many years, we have used the waste from one crop to feed the next crop!

The world continues to move slowly; population increases; New England cannot feed her children, and the great West opens its storehouses; the struggle for existence goes on;

and if the farmer is going to keep up in the race, he must raise better crops at less expense than ever before. A third epoch in agriculture is now passing over us. We are asking to know just why and how certain substances feed crops. A farmer wants to know what are the substances in plants; how the plants get these substances; what is the relation of his soil to certain crops; and he turns to the chemist for a reply to these questions.

All substances are divided into two classes: *organic*, and *inorganic* or *mineral* substances. If you burn a thousand pounds of wheat, about nine hundred and eighty pounds, the organic substances, will disappear, leaving about twenty pounds of minerals as ash. Organic substances make over ninety per cent. nearly of all plants; they sometimes make more than ninety-nine per cent.

Though there are millions of different organic substances, yet they are all composed of four elements, — carbon, oxygen, hydrogen, nitrogen, — combined in an infinite number of different proportions. The colorless gases, oxygen and nitrogen, make nearly all the air. Oxygen is the most active of elements: leave your plough in the field, and oxygen will rust it; leave your fence unpainted, and oxygen will rot it. Oxygen is everywhere present, always fiercely active, combining with the other elements in a thousand different forms; the supporter of life, the hastener of death. Nitrogen is the least active of elements, and can hardly be made to unite with the ravenous oxygen. Because of its want of strong affinity for anything, its compounds are easily broken apart. Prussic acid, the deadliest of poisons, and dynamite, the strongest of explosives, both owe their potency to the presence among their atoms of the unstable nitrogen. Carbon we know well as common charcoal. Hydrogen is the lightest of gases; in combination with oxygen it forms water. Four elements, — the lightest gas, the most eager of chemical agents, the least active of substances, and black charcoal, — by combining these four in her laboratory, nature brings out the endless diversity of organic substances that give color and odor, healing virtue or deadly venom to plants.

We need to study only six of these, — starch, sugar and

wood-fibre, gluten, vegetable albumen and diastase. Knead some flour with plenty of water on a sieve, most of the flour will wash through, leaving a sticky, stringy mass called *gluten;* let the water that ran through the sieve stand a little while, then pour off, and the white powder that has settled to the bottom is *starch;* boil the whitish water that was poured off from the starch, and you will see little white clouds, hardened by heat, just as the white of an egg is, and hence called *vegetable albumen;* in the water there may be a little *sugar* and *wood-fibre.* Starch, sugar and wood-fibre are composed of carbon, hydrogen and oxygen, the last two being always in the same proportions as in water. Hence, tasteless starch, sweet sugar, and tough wood-fibre are all but compounds of water with charcoal. Since they are made of the same elements in nearly the same proportions, one may easily change to another; and in the plant they do continually change back and forth. Sweet and tender peas, if they stay a week longer on the vines, will be hard and tasteless, — sugar has turned to wood-fibre; pears that are put down cellar in October, hard and sour, will come up in January melting with yellow sweetness, — wood-fibre is turned to sugar. Vegetable albumen, gluten and diastase are composed of oxygen, hydrogen, carbon and nitrogen. Because of the weak and unstable character of nitrogen, these compounds are even more changeable than the others.

Diastase is found only in sprouting seeds; its use is to change starch to sugar. A grain of rye contains starch, vegetable albumen and gluten, enclosed by a rind of wood-fibre. When the sprout starts, the vegetable albumen changes to diastase. Starch is insoluble and could not be carried in the sap, but diastase is a ferment, and it turns starch to sugar. The sugar, dissolved in the sap, is carried to the growing point of the sprout, and is there changed to wood-fibre, to make the stem. When seeds are formed, the process is reversed; sugar is changed to starch, and in that form stored away to feed the young plant.

In one thousand pounds of wheat there are about twenty pounds of inorganic substances, chiefly iron, potash, soda, lime, phosphorus, sulphur, silica, magnesia.

Though the amount of the inorganic substances in plants

is but a small fraction of the organic substances, these are just as necessary as the others, and their presence or absence in the soil will determine its value. Though a ton of wheat-straw contains only four ounces of sulphur, yet without that very small quantity of sulphur the wheat would die. In one thousand pounds of rye and of rye-straw there are, —

	Grain.	Straw.
Potash and soda,	5.32 lbs.	.42 lbs.
Lime and magnesia,	3.00 "	1.90 "
Oxide of iron and alumina,	.66 "	.25 "
Oxide of manganese,	.34 "	.00 "
Silica,	1.64 "	22.97 "
Sulphuric acid,	.23 "	1.70 "
Phosphoric acid,	.46 "	.51 "
Chlorine,	.09 "	.17 "
	11.74 "	27.92 "

If two liquids of different density are separated by a thin membrane, both will pass through the membrane, the less dense moving the more rapidly. Throw a dried raisin into water; within the cells of the raisin is a dense solution of sugar, and around the cells, water. Some of the liquid in the cells of the raisin will pass out through the membrane, giving the water a sweet taste; and a larger amount of water will go into the cells, causing the raisin to swell.

The rootlets of the plant are thickly set with fine root-hairs, which are hollow and contain sap, while they are surrounded by the water of the soil, containing in solution a little of the substances of the soil. Sap will pass out through the membranous wall of the root-hair, and water will move inward *faster;* thus the juices of the plant are driven upward through the stem to the leaves. The water which has thus entered the plant, and now forms part of its sap, holds in solution whatever elements of the soil can be dissolved in water. In a good soil it will contain a little of each of the minerals named above, also a little ammonia, and other nitrogen compounds.

Charcoal, when burned, unites with oxygen to form the invisible gas called carbon dioxide. The vibration of the sun's rays tends to jar the carbon and oxygen apart, and prevent

their uniting. We all know that a stick does not burn so well in the sun as in the dark.

The carbon dioxide that is poured out from every fire, and from the lungs of every animal, forms about six one-thousandths of the air; it enters the minute openings, called stomata, on the under side of leaves. In the cells of the leaf, by the action of certain sun-rays, in the presence of the green coloring matter of the leaf, called chlorophyl, carbon and oxygen are shaken apart; oxygen is breathed out into the air; carbon is forced to combine with water that has come from the roots, forming sugar, starch or wood-fibre. If nitrogen also enters into the compound, gluten or vegetable albumen is formed.

In one thousand pounds of wheat there are, —

> Four hundred and fifty-five pounds of carbon.
> Fifty-seven pounds of hydrogen.
> Four hundred and thirty-one pounds of oxygen.
> Thirty-four pounds of nitrogen.
> Twenty-three pounds of all the inorganic elements.

Every breeze brings carbon to the plant; hydrogen and oxygen comes to it in the rain and dew; a part of the nitrogen is furnished by the air. Here, as everywhere else, Nature has done far more for man than she asks him to do for himself. If you have taken a thousand pounds of wheat from a field, and will carry back to it thirty-four pounds of nitrogen, and twenty-three pounds of lime, sulphur, phosphorus and iron, in a form to be used by plants, the land will be better than before.

In order to supply the needed fifty pounds or so, shall the farmer cart upon the land loads of stable manure, mostly water? Or shall he employ the chemist again, to find some means of giving the same good effect with less weight and bulk? It would seem to an unbiased looker-on, with no wild theories to follow, and no set notions to hold him back, that chemistry can here give the farmer aid that is valuable, say, rather, indispensable. In different plants, the amount of the different elements named greatly varies; hence, the well-known fact that certain soils or certain manures are

good for some crops, but other crops will not profit by them.

We have seen very imperfectly the principal elements of plants: to work intelligently, we must study the composition of soils. The light-brown, fine powder that we see in soil is made by the decay of vegetables, is therefore *organic*, and is called humus. Of humus there are three kinds. On sandy uplands a very light-colored variety occurs, insoluble in water, and consequently nearly useless to plants; it is called *coaly* humus. In wet places, the decaying leaves and roots give an acid taste and character to the soil; *sour* humus may be made valuable by adding lime or marl. *Mild* humus is the most readily soluble, and the most valuable of the three kinds. Humic acid, one of the constituents of humus, is the chief source in the soil from which plants may obtain nitrogen; and we have seen that nitrogen as well as the inorganic elements must come from the soil.

There is but one way of deciding what is present and what wanting in any soil; I give analyses of two soils.

Silica or sand,	93.72	92.014
Alumina,	1.74	2.652
Oxide of iron,	2.06	3.192
Oxide of manganese,	.32	.48
Lime,	.121	.243
Magnesia,	.7	.7
Potash,	.062	.125
Soda,	.109	.026
Phosphoric acid,	.103	.078
Sulphuric acid,	.005	trace
Chlorine (in salt),	.05	trace
Humic acid,	.89	.34
Other organic matter,	.12	.15
	100.	100.

The first produces very fine clover; the second will not grow red clover, which is attributed to the absence of sulphuric acid and of chlorine in the second. The amount of organic matter supplying nitrogen is very small in both; but as clover obtains all its nitrogen directly or indirectly from

the air, the small amount of nitrogen will not affect that particular crop. In this case, the addition of gypsum and salt to soil No. 2 would probably make it produce clover. It would be easy to multiply such examples, but the conclusion that would be drawn is just as well seen from these two; that is, the great practical value to the farmer of the intelligent study and analysis of the soil of a field, that the fertilizers used may supply what that soil lacks for the growth of the crop that he requires.

The manure should supply the minerals that are needed, and nitrogen; small quantities will be sufficient if supplied in such form and at such time that the plant can use them. Nine times in ten, probably, of the loads of barnyard manure put on a field, all that the land needs is the ammonia and nitrates, to furnish nitrogen. And in these, particularly in ammonia, the liquid manure, which is so often allowed to run to waste, is the richest part. The manner of applying the food for the plant is a practical point of the highest importance. If you so work and fertilize the ground that the little growing plants have an abundance of rich nitrogenous nourishment, they will grow vigorously, send down strong roots, shoot up broad leaves; and if your neighbor has not provided equally well for his own crop, your healthy, vigorous field will take the carbon from the air, and rob the poorer and weaker plants beside them. "To him that hath shall be given" is just as true here as anywhere else.

It is by such means as I have indicated that chemistry can be made valuable on the farm; but how shall I speak of that subtile chemistry that works its changes within the plant itself. Two plants may grow side by side, fed by the same soil, warmed by the same sun; one will produce the luscious strawberry, the other is bitter wormwood. The sap will ascend through the pores of a quince-bush, but where you have grafted on a pear scion comes a change that no human chemist can explain. Above that point pears, below quinces, may be borne on the same branch. Most wonderful of all, the carbon dioxide breathed out by animals, the rotting, plague-bearing offal that might poison a whole city, touched by the divine alchemy of the grape-vine or the rose-bush, will be changed into health and beauty and sweetness.

Beside such chemistry as this, man's small efforts are insignificant indeed; but it is our place to learn and do what we can. Even by that doing we shall better appreciate the wonders of the chemistry that we can never hope to equal.

[Extract from Transactions of the Mass. Horticultural Society.]

THE CLIMATE AND HORTICULTURE OF NEW ENGLAND.

By JOHN E. RUSSELL, Leicester.

Mr. President, Gentlemen and Ladies: —

This sharp January day, with hard, deep-frozen ground and threats of lower temperature, is not unseasonable in our climate, nor does it interfere with the work of the members of our Society. It allows time for the winter meetings; and I thank you for honoring me with an invitation to address this the initial gathering of the year. Let me, sir, congratulate the Society upon the good work of the last year. I rejoice to know that our membership is enlarged, our influence spreading, our exhibitions so zealously maintained and so well attended, and our treasury in such a satisfactory condition.

At this opening meeting, a few remarks upon the climate of our region and the history of our horticulture may not be out of place.

To the horticulturist climate is a topic of ever-present interest. Like our English cousins we are always growling about it, and whenever at loss for conversation we "resume the weather." I have often thought, in the midst of one of our terrible winters which so try the courage and irritate the nerves, that our hard New England was too inhospitable to be the habitation of man. At this gloomy period I have yearned, as those who wait for the morning, for the miracles of spring, so vivid upon these northern shores, and for the beauties of June, the crown and glory of the New England year.

In my wide experience, — whether under the rosy light reflected by the tideless Mediterranean, or where the great swell of the Pacific breaks upon shores whose verdure never fails, and tropic islands the glory of whose fronded palms delights the voyager from afar, — I have experienced no such sensation of joy as comes with our delicious June. It is a new heaven and a new earth, making good to us the doctrine of compensation, and purging our minds of all unhappy recollections of winter. But it is so short!

It was in the early summer of their first experience that Edward Winslow, Governor of Plymouth Colony, wrote to England with enthusiasm of the climate and the flora, the vines, sweet with their delicious perfume, the wild "damsons," and the forest roses, and the richness of the sea-food.

No doubt he expected that June would last until December. He had yet to learn of the power of the midsummer sun, and the parching droughts that were to threaten the very existence of the colonists. His clusters of thick-skinned, foxy grapes have surely set the children's teeth on edge; his acrid damsons have disappeared from our sylva; and the treasures of food hidden in the sea-sands chiefly serve to vary our sustenance during the season of clams.

A true descendant of the Pilgrims, the eloquent Rufus Choate, said: "Take the climate of New England in summer, hot to-day, cold to-morrow, mercury at eighty degrees in the shade in the morning, with a sultry wind south-west. In three hours more a sea-turn, wind at east, a thick fog from the bottom of the ocean, and a fall of forty degrees. Now so dry as to kill all the beans in New Hampshire, then floods carrying off all the dams and bridges on the Penobscot and the Androscoggin; snow in Portsmouth in July, and the next day a man and a yoke of oxen killed by lightning in Rhode Island. You would think the world was coming to an end. But we go along. Seed-time and harvest never fail. We have the early and the latter rains; the sixty days of hot corn weather are pretty sure to be measured out to us; the Indian summer, with its bland south winds and mitigated sunshine, brings all up, and about the 25th of November, being Thursday, a grateful people gather about

the Thanksgiving board, with hearts full of gratitude for the blessings that have been vouchsafed to them."

There is a popular belief that rough and inclement climates are the especial nurses of the spirit of independence; hence the heroic lines, always quoted in the after-dinner speeches of our friends from New Hampshire: —

> "Man is the nobler growth our realms supply,
> And souls are ripened in our Northern sky."

But is it not true in history that the barren and inhospitable regions have been saved from enslaving conquest by their lack of attraction to the conqueror?

In Gibbon's first volume it is related that Scotland did not feel the yoke of imperial Rome because of her rough climate. The native Caledonians were indebted for their independence rather to their poverty than to their valor. "The masters of the fairest and wealthiest climates of the globe turned with contempt from gloomy hills assailed by the winter's tempests, from lakes concealed in blue mists, and from cold and lonely heaths over which the deer of the forest were chased by troops of naked barbarians." The boasted liberty of the Swiss has been due to the inaccessible and repellent nature of their glacier-clad Alps, while the sunny slopes of Italy have been the scenes of war and rapine.

> "Italia! O Italia! hapless thou
> Who didst the fatal gift of beauty gain;
> A dowry fraught with never-ending pain,
> A seal of sorrow stamped upon thy brow!"

The great calamities that came upon mankind early in our era, when the civilization of the world was overwhelmed by barbarians, were caused by the armed immigration of the Northern races seeking a better country. They came not as armies, but as moving peoples. They had with them all that they loved and all that they possessed: their Dacian women, their young barbarians, their troops of Scythian cavalry, their herds of coarse, rough-haired cattle; their homes were where they encamped. They left their Arctic allegiance behind; they exchanged with gladness the waters

of the Don and the Volga, murmuring under imprisoning ice, for the sunny slopes of the Arno, the Rhone, and the Guadalquivir. They left the gloom of Northern forests, the dark shadows of fir and birch, for the fruitful groves and vineyards of Italy.

The causes of the emigration that commenced a settlement upon the stern coasts of Massachusetts at the beginning of winter, when December winds howled through the forest and tossed the freezing foam upon the rocks, were not similar to those I have described.

> "No lure of conquest's meteor beam,
> Nor dazzling mines of fancy's dream,
> Nor wild adventure's love to roam,
> Brought from their fathers' ancient home,
> O'er the wide sea, the Pilgrim host!"

A thirst for freedom of the soul, freedom of thought, and a larger measure of freedom of life, — a desire that two centuries had been kindling, and which had to be satisfied, — led to the reckless attempt which, pursued with so much of suffering, destitution and misery, almost perished in the New England wilderness during that first winter, but which *did* live to found a colony and a nation. They took no thought of climate, — they lived but to die, — their vision looked beyond the dreary shore of Plymouth to that perfect climate,

> "Where everlasting spring abides,
> And never withering flowers;"

and they bore without complaint, but with much home-sickness, the fierce extremes of their new home. There is no record by thermometer of the first hundred years of the occupation of New England, as this simple and necessary instrument was not made practically available until the beginning of the eighteenth century, so that we have no knowledge of the degree of heat they experienced, but we do know from their records that in one respect the climate has changed but slightly since then, — that *drought* was an ever-present menace to the struggling colonists. The experience of their earliest planting also shows that unacclimated English plants could not bear the fervor of our sun; for, of the six acres of

barley and pease put in, not only with faith, hope and prayer, after the Christian manner, but, as a precautionary measure, well manured with fish, after the heathen Indian style, the barley was indifferent good, and the peas not worth gathering; they came up well and blossomed, but the sun parched them in the blossom, and the hope of the Pilgrim husbandman was frustrated. Their first summer was undoubtedly very early, for they began tillage in March, and it was very hot.

Subsequent seasons were later, and the English garden seeds yielded abundantly; for we have the enthusiastic testimony of the Rev. Francis Higginson, who, in 1629, wrote: "Our Governor hath store of green pease growing in his garden, as good as I ever eat in England. Our turnips, parsnips, and carrots are bigger and sweeter than is ordinary to be found in England; here are store of pompions, cowcumbers and other things of that nature which I know not."

Probably there has been little change in the climate; the forest was not so all-pervading as writers have usually assumed, — there was much clear land, and the Indians burned over great tracts, the fires running until material was exhausted, or rains quenched the flames. Now, as then, winter prevails the greater part of the year. Early in September the gardener expects frost; later in the month the low lands are hoar with rime. October, with bland, charming days, has a killing night breath. November ends even the show of vegetable life, and thenceforward, "a leafless branch his sceptre, winter rules the inverted year."

Though we have our open and mild winters at long intervals, the mean temperature is below 32°, with frequent sudden ranges below zero. In this period of intense cold, the streams are locked in thick-ribbed ice; the ground, often bare of snow for weeks, freezes to a depth of three or four feet; there is no sign of life in herbaceous plants, and the loosened winds howl o'er the pendent globe. Nor does the scene assume the beauty that belongs to vegetable growth until late in the spring; usually "Winter lingering chills the lap of May." Summer comes with June, and though it has been asked, "What is so *raw* as a day in *June?*" — from the advent of our divine month there will be one-quar-

ter of the year without frost; nature is often yet more benignant, and we have four months of warm weather.

With this climate we have a thin, hard, stony soil; the few plants necessary for the support of man (for of the thousands known to botany he uses scarcely a hundred) perish in winter, and must be continually renewed from seed, or by the preservation of their roots, bulbs or tubers.

Our summer, though all too brief, is hotter than in the tropical or equatorial region of our continent, and favorable to the growth of any plant that will mature within ninety days. Plants of warm regions that, introduced here, endure the inclemency of the winter, we call "hardy," and adopt them into our flora.

Science has labored in vain to determine why one plant endures severe cold without harm, and another withers and perishes. An inhabitant of the tropical world, stumbling over the rocks firm set in the frozen surface of a Massachusetts pasture, or floundering in the snow-drifts of a swamp darkened by hemlock boughs and gaunt with the bare limbs of birch trees, would start with amazement to see the glossy, dark leaves of evergreen kalmia or rhododendron, so like the tropical foliage of lemon, orange or cacao. If he cuts the wood, he finds it, like them, hard and fine of grain; the imperceptible, unexplained difference in character being in the power to live through the winter. This remarkable difference is also noticed in bulbs and tubers; but as yet unaccounted for.

Our cold winter does not exempt us from the introduction of pestilent weeds that are by nature hardy and cosmopolitan, and that, taking advantage of the exchanges of agriculture, travel about the globe, unbidden guests, with such vigorous aggression that their extermination, in our methods of culture, seems impossible.

Our fervent ninety days of summer, though not enough for the great majority of tropical plants, enable us to make gardens that in edible richness surpass the prodigality of the tropical world; albeit the plants which we there produce, — that minister so much to health, comfort, luxury or actual necessity, — have been introduced to our use from the far South.

The vegetable contributions of the New World to the Old were from the regions of tropic warmth. The maize, or Indian corn, though spread by savage necessity to the extreme limit of cultivation at the time of the discovery of America, was a child of the sun. Tobacco, the ubiquitous solace of life; the potato, that has enabled the world to sustain its population so easily; the tomato, chocolate, quinine, and an infinite variety of tropical flowers, were furnished from the boundless resources of the equatorial world. Imagine a pharmacopœia without quinine, — a malaria-infected world without its remedy, — people whose *un*embittered existence should be shaken and racked with chills and fever, and no antidote!

When our fathers landed upon the shores of Plymouth they could form no idea of the flora of the region. Those who lived to see the miracles of the New England spring were filled with glad surprise at its sudden beauty. They gathered with delight, first, the lovely arbutus; later, the pale, single roses of the forest. When the wild grapes blossomed, charming the vagrant breezes with fragrance, and their broad leaves unfolded, they knew why the Norseman, skirting these shores in summer, had called it a Land of Vines. Then they reddened their fingers with the wild strawberries, and told thumping stories about them in letters home, — travellers' tales, such as, that "ships might be loaded with their abundance."

It is necessary for man to plant seed and till the soil, even in savage life. I take it that the New England Indians were no mean farmers, and that their agriculture was quite extensive. The Pilgrim watched the squaw preparing the ground cleared by fire upon the banks of a stream; her simple hoe, a clamshell or shoulder-blade of deer, tied with thong of hide or muscle to a stick. They worked their land near the water, to be convenient to the great store of herring or shad, and in the mellowed earth they put one or more fish, and dropped the golden grain of maize; the Pilgrim saw its blades of tender green seek the light and shoot upward with tropical vigor, color and form. The grass grains of the Old World, waving in billowy richness, were the types they knew. Wheat, rye and barley, ancient as our race, and

making the staff that has supported the toiling steps of every generation of men, were familiar to them. What must have been their surprise when they saw this child of savage horticulture respond to the ardent kisses of the sun, spread its broad leaves, exalt its towering blossom, shed its fertilizing pollen, and ripen its prodigal grain!

It was their wonder and their safety; it was God's gift and mercy, that by it, upon these rugged shores, they might live, and that the wandering witness of his word should be preserved and established, — a proof of his lasting love and watchful power.

This bantling of the Indian squaw is now the king of all the cereals; whose field is a continent, and whose surplus loads the boards of nations that would otherwise perish. This very season the American farmers have raised in ninety days eighteen hundred millions of bushels upon lands that stretch from the sandy shores of Plymouth to the gate of the Pacific, and from where the cool streams leap to the untempered waters of the North Atlantic to the turbid tide of mighty rivers dark rolling to the Southern Gulf.

The maize was the only useful plant of the family of grasses that the English settlers found in their new home. The tame grasses of Europe that now wave in our meadows, the cereals, roots and fruits of civilized life, had to be carefully introduced, supported and cultivated, to form the wide basis of our present agriculture and horticulture.

The native flora of New England was not sufficient for the support of man. There was game in the forest, and fish in the streams and waters of the coast; but timber, ice and rocks were the sole productions of the shore. May I not say that there was not a wild plant of all our region that has ever been cultivated into value, from the time of its discovery until now? It may, perhaps, be proper to except several small fruits; and also to speak of the sugar maple, one of the most beautiful of our native trees, readily transplanted or raised from seed. It is of vigorous growth, its foliage clean and rich in summer, and when ripened in autumn gorgeous in varied colors. While yet the snowdrifts lie heavy in the wood, before the bluebird — harbinger of spring — is heard, it may be tapped, and its sap, identical in composition with

the juice of tropic cane, produces a peculiar sugar well known to us all. I have tasted it when sent to me in foreign lands, and its wild flavor has so brought back the odor of the forests of my native hills, that, sick for home, I have stood in tears upon the alien strand.

The natural emigration of plants is to kindlier soils, or to those climates that offer favorable conditions of growth. The most remarkable case of emigration is that attributed to the Cocoa Palm. Its original country is supposed to be Ceylon, where, on the coast of Colombo, there are vast groves, scarcely interrupted by other trees. These forests of palm are of immemorial antiquity; from this, or from the similar coast of Malabar, the great nut, falling into the water, is borne on the currents of the Pacific. Its germ of life and the albuminous matter within are protected by its rough shell; it may float for months, perhaps for years, until washed by the surf upon the sand of a coral island; here it sinks into the sand, — in darkness, moisture and heat it swells, sprouts and grows; the albumen of the inner shell nourishes the root; it begins as a single leaf, and at length it stands a mighty column, taller than the mast of a great admiral, bearing aloft the glory of its leaves and its centre of continuous flowers, the crowned monarch of the vegetable kingdom. Thus has the palm been distributed to all parts of the tropical world reached by the currents of the ocean.

Seeds that are winged are carried by the wind, that bloweth where it listeth; others are disseminated by birds. Some attach themselves to the hair or fur of animals, and so move about the world. We cannot tell why, when we cut off a forest of pines, oaks spring in their place; or why, from fallow lands, a forest of walnut should be evolved as from the inner consciousness of the earth. Our Massachusetts soil probably received all its share of plants that would survive upon it; it was kind to a rich variety of arborescent species, its flora containing a larger number than any other region of similar extent in the north temperate zone. The Appalachian flora, in which ours is included, has in a comparatively small area twice as many species of trees as grow naturally in all the Continent of Europe; but if the cocoa-

nuts floated on ocean currents reached our chilly shores, they never remained over winter. Our fathers soon found that the earth yielded its increase only to the hand of toil, and set themselves early to the great work not only of planting a nation in the wilderness but also of providing food for its maintenance.

At this time grasses were not cultivated in England, and the wild herbage served here, as in the British Islands, for the cattle that were imported in considerable numbers shortly after the settlement of Plymouth. Wheat, rye, barley, beans, carrots, parsnips and turnips were soon introduced, and added to the corn, squashes and tobacco of Indian agriculture; so that in 1629 planting and gardening became the boast of the colonists, who wrote back to England: "Wee abound with such things as, next under God, doe make us subsist; sundrie sorts of fruits, as musk-millions, water-millions, Indian pompions, and many other odde fruits that I cannot name."

Later botanical investigation revealed further natural richness without "the art or helpe of man," in the existence of "Purselane, Sorrell, Peneriall, Yarrow, Mirtle, Saxafarilla," and though, in their boasting, they would have included the nauseous choke-cherry as yielding clusters of cherries like grapes, they confess that the acrid juice did so "furre the mouth that the tongue did cleave to the roof thereof, and the throat wax hoarse with swallowing them." Their idea was, in such cases, to tame the fruit, which was wilder than the Indian himself, and in this direction we see the best effort of the horticulturist.

The slow process of pomology began when Governor Winthrop planted the seeds of Pippins on an island of Boston harbor, which grew, and gladdened the sight of the Puritan with blossoms that Eden knew, and in 1639, on the 10th of October, there were ten fair pippins, fruit of that seed, "there not being one apple or pear tree planted in any part of America except on that island." The next year Governor Endicott commenced a nursery of seedling trees at Salem; and, trees being scarce, and land plenty, he exchanged trees for land,—two young trees for an acre. Peregrine White, himself the earliest fruit of Plymouth

shore, planted apples; and indeed the whole colony was fully alive to the importance of apples. Quantity was desired rather than quality, the purpose of planting so largely being to make "Syder," to which our pious ancestors were greatly addicted.

The desire of the Puritan, distant from help and struggling for bare existence, to add the Pippin to his slender list of comforts, and the sour "syder" to cheer his heart and jog his liver, must be considered a fortunate circumstance. Perhaps he inclined to cider for the same reason that the Chaplain of Newgate, in Jonathan Wild's time, gave for his love for rum punch, — "because it was nowhere spoken against in the Scriptures." He found a new home for the most useful fruit that has been given to man, and a soil and climate that have improved its quality and increased its value beyond any possible expectation of the earlier cultivators. Pears were not neglected: the trees of common, heavy bearing varieties grew to great size in large orchards, the fruit being made into perry, — another species of "red-eye," now happily forgotten. It may be noted that the canker-worm was waiting for the advent of the apple, and the curculio was in ambush for the plum.

This cider interest may perhaps explain the fact that no nurseries of improved grafted fruit were established in New England until our time. The seedling trees must have grown with great rapidity and produced enormously, trees making seven to nine barrels of cider being common in all orchards. Villages of forty to fifty families made from two to three thousand barrels of cider; every cellar was full of it; it was drunk, sold, given away, and there were "woes and babblings" in consequence.

On Long Island, the Linnæan Botanic Garden of the Prince family, at Flushing, was commenced in the middle of the last century. Here were splendid collections of foreign and native fruit and ornamental trees. There were other nurseries on the island; also in New Jersey, Pennsylvania, and South Carolina, and gentlemen of this neighborhood had to send there, or to England, for trees. In 1822, John Lowell, writing in the "Massachusetts Agricultural Repository," vol. vii, p. 137, said: "We are utterly destitute in New England

of nurseries for fruit trees on an extensive scale. We have no cultivators upon whom we can call for a supply of the most common plants of the smaller fruits, no place to which we can go for plants to ornament our grounds. We have not a single seedsman who can furnish us with seeds of annual flowers upon which we can put reliance." A year later he wrote in the same journal complaining that, "A traveller may traverse Massachusetts from Boston to Albany and not be able to procure a plate of fruit, — except wild strawberries, blackberries, and whortleberries, — unless from the hospitality of private gentlemen."

The Massachusetts Society for Promoting Agriculture had been established in 1792, by wise, public-spirited, generous gentlemen. It became a beneficent institution, and still flourishes in a youth that I trust may be immortal. The value of its assistance to the general agriculture of the Commonwealth cannot be overrated, and it is always on the alert to give practical assistance to the farmer.

In 1801 this Society gave $500 for the establishment of a professorship of Natural History at Cambridge, and a committee was appointed to procure subscriptions for its permanent endowment. This resulted in the establishment of the Botanic Garden connected with the University, and was one of the causes that led to the formation of the Massachusetts Horticultural Society in 1829. From this time the pursuits of gardening and pomology took their rise, — evidences of increasing taste and a more refined civilization.

"The garden," said Lord Bacon, "is the purest of human pleasures; it is the greatest refreshment to the mind of man, without which buildings and palaces are but gross handiworks; and man shall ever see that when ages grow to civility and elegancy, men come to build stately, sooner than to garden finely, as if gardening were the greater perfection." It is a pursuit alike adapted to either sex; it is the relaxation of genius, a refuge from the toil of commerce and the cares of state.

Think what it adds to the refinement and luxury of life. Look back in the records of fifty years, or examine the recollection of each one here present, and see how small and poor was the list of fruits and their varieties; and those were con-

fined to the gardens of the wealthy. Now, I may say, that in my annual visits to the agricultural fairs, I see each year, in remote towns of the Commonwealth, exhibitions of fruit and flowers such as the whole nation could not have made in my boyhood.

The grape — the type of luscious fruits, the inspiration of poetry, the adornment of eloquence — is but of yesterday in our cultivation. It is but about sixty years since valuable American varieties were first brought into notice; now we have numerous seedlings and hybrids brought into our market by the ton from our own vineyards, and sold as cheaply by weight as apples.

About the same time that this work began the berries were confined to the wild varieties of the woods and the fields. We have only to go back to 1839 to find on the record that then was first exhibited the Hovey's Seedling Strawberry, which so stimulated the emulation of gardeners; and the splendid variety originated by President Wilder, with its surpassing flavor, was not given to the world until 1865. Now the list of that noble family is as long as the British peerage.

What time is left me to speak of the progress made since the foundation of this Society in the cultivation of flowers! What great proportions do we see in the trade of the florists! What an increase in the taste of the people! How flowers are taken to decorate every scene of the drama of existence! How bare would the world seem without the refinement of their presence! Our feeling for them is fitly expressed in the language with which Eve, when expelled from the forfeited garden, mourns with deepest tenderness: —

"O flowers,
That never will in other climate grow,
My early visitation, and my last at even,
Which I bred up with tender hand
From the first opening bud, and gave ye names!
Who now shall rear ye to the sun, or rank
Your tribes, and water from the ambrosial fount?"

[Extract from Transactions of the Mass. Horticultural Society.]

THE PROPAGATION OF TREES AND SHRUBS FROM SEED.

By JACKSON DAWSON, Jamaica Plain.

I have been asked to make a few remarks on the raising of trees and shrubs from seed. It is an old subject, and one that has been spoken and written on from time immemorial until the present day; so that I feel as if I had nothing new to tell. But we are a new generation, and, notwithstanding all that has been said upon the subject in the past, there are many among us who hardly know anything about the life of a tree, or how long it takes a seed to germinate; and scarcely give any thought to a matter which should now attract the attention of every intelligent observer of nature who takes an interest in the forest wealth of our country. And there is no reason why every man, who has a lot of barren land, should not plant and care for a few acres of trees every year, using the kinds most suitable to the soil of his farm, and thereby securing a permanent investment for his children, as well as adding to the resources of his country. Our forests are fast disappearing, and if we keep on doing in the coming generation as we have done in the past, we shall soon have a country of barren hills and treeless plains. Our watercourses will be torrents in the spring, and dry, gravelly beds the rest of the year. I might mention a few of the causes of the destruction of trees that could be prevented. *First*, the woodman, who cuts all that is of any use to him in a commercial way, and destroys all, or nearly all, that is left. *Second*, forest fires, which are our greatest curse, in whatever way they may originate, — it may be a spark from a locomotive, a wad from the gun of some sportsman, or the smouldering fire left by some

camper-out, which has been blown about by the rising wind; these often start fires that may destroy much valuable property. Many people do not think of the value of a tree, and do not care where a fire may end so long as it does not affect their interest. I have seen many acres of woodland burning, not ten miles from Boston, and no one attempted to stop it until it threatened to burn some little shed; then the whole community turned out to stop it, but as long as it kept in the woods they did not care. This matter should be looked into, and strict laws be made, which would protect all who might plant trees or forests; for they are one of the greatest sources of national wealth and comfort. I might say that there is scarcely a business that can be successfully carried on without the use of forest trees or their productions.

But I am getting away from my subject. The raising of trees from seed is the natural way of propagating them. Nature shows us that, and employs many agents to carry out her designs. In the first place, seeds drop from the trees to the ground and are covered by the falling leaves, or by the grass and weeds, which keep them from the drying winds until they germinate. They are scattered by the winds, and many fall in the crevices of rocks, and on good ground, or other favorable situations; they are floated down rivers and brooks, and are left in the rich mud along the banks. They are carried many miles from their original station by the birds; and the larger seeds, such as acorns and nuts, are carried away by squirrels, mice, and other animals, and buried for future use as food, and a great many of these germinate. I think that for many rows of fine oaks and hickories along the boundary walls of old farms we are indebted to the planting of the squirrels. While we can learn much from nature, we can also improve upon her methods, and supply ourselves with trees in a more economical way. It is true, if nature is left to herself, and men stop destroying, she will soon cover up the ruins made by man, for she sows with a liberal hand; but there are so many enemies at work, and so many conditions to take into consideration, that only a small percentage of the seed that drops to the ground germinates; possibly not one in a thousand comes to maturity.

For this reason we cannot afford to raise our forests as nature shows us.

The sowing of tree seed where the trees are to remain is poor economy, and should not be undertaken except where it is impossible to plant; such sowing should be the exception, not the rule. A much greater quantity of seed is required; it necessitates more labor; more spots have to be replanted, and it is not generally satisfactory in its results. The soil and situation are so varied that the seed cannot be properly cared for, as it can be in the compact form of frames, seed beds, or nursery rows, where they can be protected from insects or inclement weather.

The first consideration in seed-sowing is to determine what you want to plant; the second, to procure your seed as fresh as possible; the third, to prepare a suitable soil and situation to plant them in; the fourth, to know what depth to cover them, and how long to wait for the seed to come up. It would be impossible for me at this time to go through the whole list of trees and shrubs that would stand the climate of New England; therefore I will confine myself to those that are most useful. Except in a few cases given for the sake of illustration, those named in the following list are all hardy in the vicinity of Boston, and are representatives of most of the families of trees that will stand our climate: —

Acer rubrum,	Red Maple.
" *saccharinum*,	Sugar "
" *dasycarpum*,	White "
" *platanoides*,	Norway "
Æsculus Hippocastanum,	Horse Chestnut.
Ailanthus glandulosa,	Tree of Heaven.
Alnus glutinosa,	European Alder.
Amelanchier Canadensis and varieties,	Shad-bush.
Betula papyracea,	Paper Birch.
" *lenta*,	Black or Cherry Birch.
" *nigra*,	Red or River "
" *alba*,	English White "
Carpinus Caroliniana,	Hornbeam.
Carya alba,	Shell-bark Hickory.
" *sulcata*,	Western Shell-bark Hickory.
" *porcina*,	Pig-nut.

Carya amara,	Bitter-nut.
Castanea vulgaris var. *Americana*,	American Chestnut.
Castanea pumila,	Chinquapin.
Catalpa bignonioides,	Catalpa.
" *speciosa*,	Western Catalpa.
Celtis occidentalis,	Nettle tree or Hackberry.
Cercis Canadensis,	Judas tree.
Cladrastis tinctoria,	Yellow-wood.
Cornus florida,	Flowering Dogwood.
Cratægus Crus-galli,	Cockspur Thorn.
" *tomentosa*,	Black or Pear Thorn.
Cercidiphyllum Japonicum,	
Diospyros Virginiana,	Persimmon.
Fagus ferruginea,	American Beech.
" *sylvatica*,	English "
Fraxinus Americana,	White Ash.
" *pubescens*,	Downy "
" *sambucifolia*	Water "
" *excelsior*,	English "
Gleditschia triacanthos,	Three-thorned Acacia.
Gymnocladus Canadensis,	Kentucky Coffee tree.
Ilex opaca,	American Holly.
Juglans cinerea,	Butternut.
" *nigra*,	Black Walnut.
Kalmia latifolia,	Mountain Laurel.
Liriodendron Tulipifera,	Tulip tree.
Magnolia acuminata,	Cucumber tree.
" *cordata*,	Yellow Cucumber tree.
" *Umbrella*,	Umbrella tree.
Morus rubra,	Red Mulberry.
" *alba*,	White "
Nyssa multiflora,	Tupelo, or Sour Gum.
Ostrya Virginica,	Hop-Hornbeam.
Pirus Americana,	American Mountain Ash.
Platanus occidentalis,	Button-ball tree.
Populus balsamifera,	Balm of Gilead.
Phellodendron Amurense,	Amoor Cork tree.
Prunus serotina,	Wild Black Cherry.
Quercus alba,	White Oak.
" *bicolor*,	Swamp White Oak.
" *palustris*,	Pin Oak.
" *rubra*,	Red "
" *coccinea*,	Yellow-barked Oak.

Rhododendron maximum,	Great Laurel.
Robinia Pseudacacia,	Locust.
Salix alba,	White Willow.
Sassafras officinale,	Sassafras.
Tilia Americana,	Basswood.
" *Europœa*,	Linden.
Ulmus Americana,	White Elm.
" *racemosa*,	Corky "
" *campestris*,	English "
" *montana*,	Scotch "
Viburnum Lentago,	Wayfaring tree.
Taxus baccata var. *Canadensis*,	American Yew.
Ginkgo biloba,	Maiden-Hair tree.
Larix Europœa,	European Larch.
Juniperus Virginiana,	Red Cedar.
Thuja occidentalis,	American Arbor Vitæ.
Abies balsamea,	Balsam Fir.
" *concolor*,	Rocky Mountain Silver Fir.
" *pectinata*,	European Silver Fir.
Tsuga (Abies) Canadensis,	Hemlock.
Pseudotsuga (Abies) Douglasii,	Douglas Fir.
Picea nigra,	Black Spruce.
" *alba*,	White "
" *pungens*,	Colorado Spruce.
" *excelsa*,	Norway Spruce.
Pinus Strobus,	White Pine.
" *resinosa*,	Red "
" *rigida*,	Pitch "
" *sylvestris*,	Scotch "
" *Austriaca*,	Austrian Pine.

As you perceive, the majority of this list are American trees. I know there are many foreign trees that will do well in New England; but, without being partial, I must say I believe that, with few exceptions, American trees are the best in the American climate, both for use and profit; and in almost all undertakings in this country the first question is: Does it pay? Of course we have those among us who take a special delight in all that is beautiful, and gather together from all parts of the world everything in the plant line that can be grown in our climate. Such men are public benefactors, but we have too few of them; most of those

who plant want to reap the benefit, either directly or indirectly, as soon as possible, and to such I say: Let us plant American trees.

Soil and Situation.

In selecting a place for the seed beds, the soil for all large seeds should, if possible, be a deep, rich, mellow loam, avoiding, if possible, all thin, gravelly soils or heavy clays. The soil should be well manured with good, rotten manure, one year old, and ploughed or trenched from twelve to fifteen inches deep, and well pulverized with a harrow. All course stones, quitch-grass, or other rubbish, should be raked off, so as to have the land in the finest condition possible. If the land is full of weeds, it would be well to manure heavily and plant one year with crops that would be well cultivated, or to plough it frequently during one season, so that it may be as clean as possible when the time comes for sowing. If there is anything that tries one's patience, it is attempting to grow seedlings in a soil that is already full of weed seed. The land should be well sheltered from the north and west winds, either by a hedge or fence. If it is springy or low, it should be well drained. If the seeds are to be sown in beds, they should be laid out five feet wide, with an alley or pathway two and a half feet wide; this will give ample room to work the beds from both sides. The beds should be raked fine, and if to be sown broadcast they will then be ready for the seed. A great many people prefer to sow broadcast; but I think that method requires more labor and care in weeding. I prefer to sow in rows nine inches apart across the bed, — especially if there are a large number of varieties, or only a limited number of plants are wanted, — or in long nursery rows eighteen inches apart, if to be worked by hand, or from two and a half to three feet, if to be cultivated by horse-power. The reason I prefer the short rows is, that in beds so planted you can keep the soil well stirred between them, which you cannot well do when sown broadcast; they are also easier to shade and water, if necessary, than the long nursery rows, and in the fall they are much more easily protected.

Sowing.

The seeds should never be sown when the ground is wet, or when it is raining; the soil at the time of sowing should be neither wet nor dry, but in such condition that it can be raked without clogging. If sown when wet the soil is apt to bake hard, and a great many seeds will scarcely come through, while, on the other hand, if the soil is too dry the seed is apt to work out unless covered deeper than is desirable.

A supply of water should always be at hand ready to use during dry weather on all light-rooted plants; but for large, deep-rooted plants this is unnecessary, except in protracted droughts. It is also well to have a number of light lath screens to shelter the most delicate plants from the hot sun. Having the ground well prepared, and all else necessary, we can begin sowing as soon as we can get the seed. If in the fall, we begin with the oaks, as acorns do not long retain their vitality, out of the ground. Neither does the seed of chestnut, chinquapin, hickory or beech. To insure good success these must all be planted, or put in boxes of earth, as soon as possible. If sown broadcast the nuts should be scattered thinly and evenly over the bed, pressed down with a light wooden roller, or the back of a spade, and covered a little more than the diameter of the seed, — which would be nearly an inch for beech, chestnut and oak, and from one to two inches for hickory, black walnut, butternut and horse chestnut. If the same seeds are sown in drills they should be from two to three inches deep, and from one to two inches apart in the row. If not pressed down they will need from half an inch to an inch more covering than those pressed down. Some prefer to make shallow drills with a plough and sow the nuts very thickly; this will give a great many more plants to a given space, but they will not be so strong.

The Maples, with the exception of *Acer rubrum* and *Acer dasycarpum* (these two species ripen their fruit in May and June), should be sown as soon as possible after gathering, and, whether in drills or broadcast, should not be covered more than twice their diameter. If covered too deep they

sprout and rot, not having strength enough to break through a great depth of soil. If maple seed is allowed to get thoroughly dry, and is kept so until spring, very few, if any, will come up until the second year; while, if sown as soon as gathered and subjected to a good freezing, the greater portion will come up the following spring; though a few may wait until the second year.

The Ash (*Fraxinus*) must also be sown as soon after gathering as possible, if wanted to come up the first year. The *Carpinus* (Hornbeam) and the *Ostrya* (Hop-Hornbeam), unless sown in the autumn, will not come up until the second year. The *Nyssa* (Tupelo), *Cornus florida*, *Amelanchier Canadensis* (Shad-bush), *Celtis occidentalis*, the Viburnums and Thorns, seldom come until the second year, although there are a few exceptions, as some varieties will come if exposed to freezing, while of others not a seed will germinate even if frozen. The plum, peach, apple and pear never come up evenly the first year unless the seed has been frozen or kept in boxes of moist earth. A great many roses will not come up the first year, even after having been frozen, although the seed of hybrids will, if frozen for a week or two, come up in less than a month. The Tulip Tree invariably takes two years, and, as the proportion of good seed is as one to ten, it should be sown very thickly to insure even an ordinary crop. I find a good plan, which saves much time and labor, is to take some good-sized boxes, and fill with seed and fine sand in alternate layers, burying the box in a well-sheltered place and leaving it there one season, lifting out the sand in the spring and sowing the seed thickly in rows, and covering lightly.

Such seeds as those of *Cercis Canadensis*, *Gleditschia triacanthos*, *Cladrastis tinctoria* and *Gymnocladus Canadensis*, being very hard, should have boiling water poured over them, and then stand for twenty-four hours, when they may be passed through a sieve, the mesh of which corresponds to the size of the seeds to be operated upon. All those not passing through the sieve may be considered fit for sowing, while the rest should be treated to another hot bath until they have all swollen to the required size. If sown dry they will keep coming up a few at a time for a

year or two. The Ailanthus, Catalpa, Morus, Platanus, Birches and Alders are best sown in spring, as soon as the ground is dry enough to work. The ground should be very fine, and, whether in beds, broadcast or in drills, the seed should be very lightly covered; and if a slight screen or shade were used it would be of great benefit to the young seedlings until they had made the second or third rough leaf, when the shade could gradually be dispensed with.

The White and Scarlet Maple, the Elms and *Betula nigra* ripen their seeds in early summer, and should be sown in freshly prepared beds as soon as gathered. At this time of the year the weather is often quite warm and dry, therefore the summer-sown seeds should be carefully attended to as regards watering, and possibly light shade should be given. Where a large amount is planted, and no screens are at hand, birch brush laid thinly over the bed is a great help. If well taken care of, they will make plants from six to twelve inches high the same season. I would say, before going further, that my rule is always to cover seed sown out of doors in any ordinary loamy earth a little more than their own diameter, and if very light and sandy nearly twice as deep; but if the soil is a clay, as lightly as possible; and it makes no difference whether broadcast or in drills. I know there are a few trees whose seed will come up if covered quite deep, but they are exceptions, not the rule.

The Magnolia should not be sown out of doors in this climate before the 20th of May, as it does not do well if sown when the ground is cold. The Holly (*Ilex opaca*) is the slowest to germinate. Treated like other seeds, a few — say one in a thousand — will come up in the first year, a few hundreds the second year, and the remainder the third year. Such has been my experience. The Black Alder takes two years.

Such seeds as those of Magnolia, Rose, Mountain Ash, *Cratægus*, *Celastrus*, *Euonymus*, and Viburnum, which are inclosed in a fleshy pericarp or pulp, where space is of account, and also for convenience of sowing, I macerate in water at seventy or eighty degrees for one or two weeks, when they may be washed out and sown before they are thoroughly dry. This often helps germination, and more in

the magnolia than any other plant I know. If the magnolia is sown when gathered, there is an oil in the pulp that surrounds the seed which, as soon as it begins to rot, seems to penetrate the seed and make it rancid. I have frequently noticed that of the seed of the magnolia that was not washed clean, few germinated; the pulp, in rotting, so soured the soil that it became full of fungus, which damped off many of the young plants, necessitating their removal to fresh soil to save them; while of those washed and sown under the same circumstances all came up and grew well. Of course this may not occur in nature, where the seed is exposed to the air and weather, or eaten by the birds and voided; but I am speaking of artificial cultivation. When magnolia seed is to be sown out of doors in New England, it is best, after washing it out, to put it in pots or boxes of sand, — that is, in alternate layers of sand and seed, — and place it in a frame or cellar, where it does not freeze, until the time of sowing in May. This is a good way to keep seeds for which we may have no place prepared, or which may arrive in late fall or winter, when it is impossible to get them into the ground. Very often it is more convenient to put seeds away in this manner until spring, than to sow in the fall; but it will not answer for seeds which need frost.

When seeds are sown in the fall, it is well, as soon as the ground is frozen, to cover the beds or rows with a light covering of hay, pine-needles or leaves, which will keep the ground from heaving, and the heavy spring rains from washing up the seeds. If closely looked after, the covering may be left on until the seed shows signs of germination, which, in the case of large nuts, will be in June, when it should be carefully removed; this will also save a great amount of weeding.

All seed beds and rows should be kept free from weeds; and, except where sown broadcast, as soon as up the ground should be hoed or cultivated frequently; this causes the young plants to push with greater vigor, and makes them better able to withstand drought. If the weather becomes very warm and dry, the beds or rows of young seedlings should be well watered once or twice a week, — not by a slight sprinkling on the surface, but by a good, thorough

soaking, wetting the ground six or eight inches in depth. After the 1st of September the waterings may be discontinued, to allow the plants to ripen up their growth.

At the approach of winter all young seedlings that were sown in drills will stand better if a plough is run between them throwing a furrow against the stems, so as to cover them several inches deep; this keeps the young plants from heaving with the frost, and also keeps the water and ice from settling around the young stems, which often causes great injury. Those sown broadcast should have a slight covering of hay or leaves, as soon as the ground is frozen, which is usually from the 25th of November to the 1st of December in this vicinity.

Second Year's Treatment.

About the first or second week in April the covering should be removed, the young trees carefully taken up, and the tap roots cut well back; the cuts should be clean and smooth, so they will quickly callous and send forth plenty of young fibres, which would take some time if the cuts were not smooth. If any of the tops are crooked they should be cut back to a good, strong eye; this will cause them to make a straight leader. When taking up the young trees, they should not be exposed to drying winds or hot sun, even for a few moments; but as soon as taken up they should be tied in bundles, and the roots well sprinkled with water, and covered with a mat or piece of old bagging, and kept moist until they are planted. There is no doubt that a great many failures in tree planting could be traced to the drying up of the roots before planting, and it has often been a wonder to me how some trees grew at all, considering the treatment they received.

The Nursery.

Having a good piece of land well prepared, either by trenching or ploughing, mark out rows three feet apart with a spade or plough; if with a plough go twice in a furrow, which will usually make the drills deep enough for trees one year old, and, if they are to remain only one year, one foot apart will do for the larger growing kinds, and six inches for

the smaller ones; if to remain a longer period a much greater distance will be required.

In transplanting trees the roots should be well spread and the soil worked well in about them, and well firmed with the feet. Our seasons for planting are often so short that we have to plant in all kinds of weather, though it is best not to plant when the ground is wet, if it can be avoided. The best time is when the soil is dry enough to crumble easily; it can then be worked among the finest roots, even if there are a great many of them, by taking hold of the tree and giving it three or four good shakes as the soil is being spread around the roots; but it is hard work to get it among the roots when it is wet and pasty. After planting, weeds should never be allowed to get a foothold in the nursery, but it should be cultivated at least once every two weeks, and all weeds cut out with a hoe between the plants. This will help the tree to withstand a long drought much better than it otherwise would, and at no great cost.

At the end of the second year almost all deciduous trees, if for forest planting, will be as large as it is profitable to plant in large quantities. If wanted for ornamental purposes they will need to be transplanted at least every two or three years, and carefully pruned into proper shape until they have reached the desired size. If often transplanted they may be successfully removed when from fifteen to eighteen or even twenty feet in height; though I believe that vigorous young trees, from one to three feet high, when set out where they are to remain, will make much finer specimens, if soil, preparation and care be equal.

The Conifers,

such as Pine, Spruce, Larch, Cedar and Hemlock, require much more attention and care to grow from seed than any other class of trees, and many of the finest kinds it is impracticable to raise out of doors in our New England climate, though the common ones, with care and attention, may be raised quite successfully. The ground for these seeds should be a light, rich loam, deep and well pulverized, or, if not rich, made so with a good dressing of well-decomposed manure. The beds should be laid off five feet wide,

and the alleys three feet. Along both sides of the beds, at intervals of five or six feet, drive a row of small posts that will rise six or eight inches above the surface of the beds. The beds should be a few inches higher than the paths, so that water will not stand on them. The situation should be as sheltered as possible, both from the mid-day sun and drying winds; the north or east side of a hedge or fence is a favorable position. The beds being all prepared, and raked very fine, as soon as the weather becomes settled — say from the 10th to the 20th of May — the seed may be sown thinly, in rows six inches apart, across the beds, or broadcast, and slightly covered, — certainly not more than twice their own diameter. The sowing in rows is most convenient in working them, both in the way of keeping the beds clean and stirring the soil among the young plants. If sown broadcast they should be lightly raked in and the bed rolled with a light wooden roller. I would here say that all seeds sown during warm, dry weather, are much benefited by having the ground lightly rolled over them. The sowing being completed, place on the posts before mentioned lath screens made the width of the bed, with the laths not more than an inch apart. This will screen the plants from the sun and in part protect them from the birds, which often pick up the young seedlings that are just breaking ground. If no laths are handy the seed beds can be covered with pine, hemlock or cedar branches, quite thickly at first; but the beds must be watched carefully, and as soon as the young plants begin to appear the branches should be gradually removed, until only enough are left to slightly shade the young plants, and these should be raised some inches above the plants. It is a good plan, where pine needles are plenty, to cover the seed bed thinly between the rows with them; this keeps down the weeds, saves much watering, and keeps the soil from washing or baking. If the ground is very dry at the time of sowing they will require a slight watering; otherwise they will not need it. In my experience there are few seeds that require so little water as those of conifers during germination.

The critical time with young conifers is the first three months of their existence, until they have made the crown

bud; after that time there is very little danger, but until then extreme watchfulness is very necessary; a great quantity of rain or a scorching sun will often prove fatal to thousands. Stirring the soil after heavy rains, and tilting the screens as soon as the sun is gone from them, or sifting dry soil amongst the beds of over-wet seedlings, is of great benefit. After the muggy weather of August is past they will require very little care the rest of the year. At the approach of cold weather they are best protected by a slight covering between the rows, and a few pine branches or a little meadow hay spread over the tops of the young plants will keep them in good condition until spring.

The Pines, such as the Scotch, Austrian and Red, should not stand more than one year in the seed bed without transplanting, unless sown very thinly. The White, Black and Norway Spruces will hardly be fit to transplant until the end of the second season. The Larch makes better plants if transplanted at one year, but will stand two if thinly sown. The Silver Fir, Balsam Fir, Hemlock, and others of that section may stand in the seed bed two years, while the Arbor Vitæ should be transplanted after the first season. The seeds of the *Juniperus* and *Taxus*, of all species, do not germinate until the second year, and it is well to treat them as I have recommended for all slow-growing seeds. The Ginkgo, if fresh, will come up the first year, though I have had them lying in the ground two years. The *Pinus Cembra* and other Stone Pines will lie in the ground until the second year, though a few may come up the first.

The seeds of the Conifers, with the exception of the Silver Firs, will, if kept in a cool, dry place, retain their germinating powers for a number of years, and even under adverse circumstances. A few years ago we had some branches of *Pinus contorta* sent us, which had the cones of six years upon them. Each cone was opened separately and the seed carefully sown and labelled, and a portion of all but one grew, and that one was only two years old, while the oldest represented the seventh year. White, Scotch, Austrian and Pitch Pine seeds came up fairly after being kept five years, and might possibly have been several years old when received. I have found in my experience that too much

moisture is fatal to the germination of old seeds, especially resinous or oily ones. If sown in soil that is barely moist, and covered with dry sphagnum, so as to prevent the escape of the little moisture in the soil, many will grow; while if treated in the ordinary way the seed will swell and then rot.

A friend of mine, who does not like too much care, has a very simple way of raising annually several thousand seedlings of the Norway Spruce, and no doubt other evergreens might be grown under similar conditions. At the back of his house he has a white pine grove, which is trimmed up ten or fifteen feet; the soil is a light, sandy loam. In this he digs several beds, rakes them fine, and early in May sows the seed, rakes it in lightly, and sprinkles the bed lightly with pine needles. If the weather is very dry he gives the bed one or two waterings; if not dry, he lets it in a great measure take care of itself. In these beds the seedlings remain two years, when he transplants them into nursery beds, where they soon make nice young plants.

The Box System.

The remarks that I have made would apply to those who wish to raise trees in large quantities, and where the loss of a few hundreds in transplanting would be of no material account. To those who might wish to plant an acre or so every year, and want no failures, I would recommend another system, which requires less space and labor, though possibly more attention, but in the end any one could transplant the most difficult trees, such as oak, hickory or chestnut, with no loss. For want of a better name I have called it the "box system." No doubt it has often been used, but I have not heard of any one using it largely except myself. By this method every root is preserved, and not even a fibre destroyed; there are few, if any, large tap roots to cut off, and even if grown in the nursery afterwards they lift with finer roots than the seedlings grown in the ordinary way; and though they will not make so vigorous a growth the first year as they would in the open seed bed, at the end of the second year after transplanting they are ahead of those of the same age grown in the ordinary way, and with no failures. Nine years ago we transplanted from the seed

boxes to a hillside, in sod ground, with no preparation except to turn over the sod with a spade where each tree was to go, some hundreds of oaks one year old, and to-day they are fine young trees, from six to nine feet high, well formed, and much more vigorous than those grown in the nursery, which have had a great amount of care and labor bestowed upon them. I believe that if many of our early planters had used this system in growing oaks, hickories, and other hardwood trees, they would not have had so many failures to complain of.

In the first place procure a lot of common boxes, such as may be had at any grocery store; any kind of boxes will do, though a uniform size is best, as they occupy less space in a six-foot frame, when packed away, than boxes of various sizes would. I usually get those that have contained canned goods, or soap, as they are nearly equal in size, and with two cuts of a splitting-saw you have from each box three flats, from three to four inches deep, which is a good depth for any ordinary seed. With a half-inch auger bore three or four holes in the bottom of each box for drainage. This will be sufficient for large-rooted plants, while the finer seeds will require to be well drained with broken pots, coarse siftings of peat, or any coarse material that will allow the moisture to pass off readily. As soon as the seeds are ripe, in the fall, get together a good pile of compost, made as follows: two parts rotten sod, one part peat, and one of sand, and if the seeds to be sown are oak, hickory, beech, chestnut or walnut, add a portion of good rotten manure. For such seeds as I have mentioned fill your boxes two-thirds full of the compost, and press down firmly with a board or the hand. Sow the seeds evenly and press them down in the soil, covering them from half an inch to an inch in depth, according to their size. On one corner of each box smooth off a place with a plane or knife, rub over with white lead, and write the name of the seed and the date of sowing. This takes only a few minutes, and is of much value afterwards, especially where a great variety of seeds is sown. It is much better than labelling in the ordinary way, and there is no danger of the record being lost in moving the boxes from one position to another. The finest

seeds — such as maples, elms, birches, alders, and others — should be covered, according to the size of the seeds, about their own diameter. After sowing, the seeds should have a good watering with a fine rose, to settle the soil. The boxes can then be piled four or five deep in a pit, the sashes placed in it, and at the approach of cold weather they may be covered with meadow hay, or leaves. This does not keep the boxes from freezing, but when once frozen it keeps them so until spring. If no pit is available the boxes can be piled six or seven deep in a well-sheltered spot, covering the upper boxes with a few boards, the whole to be covered with leaves or other litter. In the case of all the seeds I have mentioned as taking one or more years to germinate it is unnecessary to cover the boxes with litter; but it is well to cover with boards, so that mice or squirrels may not get at the seed; and in many cases seed that has been so frozen will often come up the first season, which otherwise would not have come until the second. As soon as the weather is settled, which is usually about the middle of April, choose a well-sheltered spot, level, and handy to water. If the aspect can be an eastern or southeastern one I like it better, as they get the early morning sun, but not the scorching sun at noonday. Place all the boxes containing the nuts, acorns, and other large seeds together, in beds of three boxes wide. This will make it very compact, and much easier to care for them than if the boxes containing seeds of the same class are scattered about. The only attention these will require is to keep them well watered and free from weeds; but for such seeds as maple, ash, *Carpinus*, *Cratœgus*, elm, *Cladrastis*, and others of like nature, it would be well to cover the boxes with lath screens until they have made the second or third rough leaf, when they might be gradually hardened off and finally exposed fully to air and light. If a few sashes could be spread to protect all delicate growing seeds it would be of great advantage, and as soon as well up they could be treated the same as the others.

The use of lath screens on seed beds saves a great amount of labor in watering, and if the plants are neglected for an hour or so the results are not so disastrous as when the young seedlings are fully exposed to the sun. Any boxes

of seeds that do not come up before the last of June will hardly appear that year, but will require to be kept moist, the same as the growing plants. I usually place all such boxes together in a shady spot and cover them to the depth of an inch or more with sphagnum, and by giving them a good watering once or twice a week they are carried safely through the summer. At the approach of cold weather they are gathered together, piled five or six deep as before, and covered for the winter. When spring comes on they will need to be treated as seed that has just been sown. For the finer seeds, such as azalea, rhododendron, kalmia and others, a special treatment is required, which I will speak of later.

In the fall of the first year the boxes of young trees may be gathered together and wintered in a deep pit or frame and slightly covered with meadow hay. If no frame is available, three or four inches of pine-needles or leaves may be placed over the boxes, and they may then be left until spring; but on no account should the boxes be left without any protection, as the young seedlings will then suffer very much in so little depth of soil.

All seedling trees can be transplanted when very young as easily as cabbages or tomatoes if taken as good care of, and many of them are benefited by the operation. We transplant thousands of them every year with but little loss. The best time is when they are making their first or second rough leaf.

In the spring of the second year all the young seedlings should be transplanted from the seed boxes to the nursery beds, or the larger ones planted where they are to remain; and for chestnuts, hickories and oaks, I believe it is best to plant them from the seed box to the field where they are to remain. If planted in nursery beds or rows the treatment will be the same as I have spoken of under the head of treatment in nurseries.

The boxes I have mentioned are usually from fourteen to sixteen inches square, and will hold from 100 to 125 oaks, hickories, chestnuts or beeches; 175 to 200 ashes or maples; 250 birches or elms; and so on according to the growth of the plants. Where a greenhouse can be used for this

purpose, with frames to harden off the young seedlings, much better results can be obtained, and many of the finer seeds can be grown, which it is next to impossible to grow in large quantities out of doors.

In conclusion I would say, that while I have not mentioned every tree by itself, the general principles are the same for all; that, as a rule, the soil should be of the best description and sheltered; that all seeds should be covered only a little, if any, deeper than the diameter of the seed; that they should be kept clean from weeds, the watering well looked to, and the shading, in the case of the finer seeds, be carefully attended to. They should be protected the first season, and in the end will well repay all the care and attention that have been bestowed upon them; and any one owning a few acres of land, who will plant a few boxes of chestnuts, black walnuts, beech, oak, hickory, or other hardwood trees, that are usually considered so difficult to transplant, after growing them one year in the boxes and transplanting the following spring where they are to remain, will be astonished to see how much land can be covered in a few years with healthy young growths of hardwood with very little trouble or expense. And in New England, as well as in other parts of our country, we have too many acres lying idle, which it would be more profitable to plant with trees than anything else.

Rhododendrons, Azaleas and Kalmias.

The propagation of these from seed demands great attention and care, and cannot be successfully done out of doors, but requires a greenhouse. The best soil to grow young seedlings of this class is composed of good peat, loam and sand, in equal parts. The sand should be fine, but sharp and clean, having no clay or iron in it. Earthern pans are best to sow the seed in, as there is less danger of fungus than with boxes; but after the first transplanting boxes may be used. Being all ready to sow, — say about the first week in January, — the pans should be well drained by filling them one-third with broken crocks, over which put a

covering of sphagnum, or the coarse siftings of peat, so that the soil will not work in among the drainage; then put in about two inches of the compost mentioned above, have it well firmed, and give the pans a gentle watering with a fine rose to settle the soil. As soon as settled the seed can be sown quite thickly, but evenly, over the surface. They should then be covered with the slightest possible covering, — not more than the sixteenth of an inch, — after which put over the pans a covering of fine sphagnum, give a gentle syringing, and place in a temperature of seventy degrees. After sowing, the seed should on no account be allowed to get dry; but at the same time saturation should be avoided. The seed will usually come up in from two to three weeks, and in the meantime the pans will have to be examined occasionally to see if the seed is coming. As soon as it shows signs of germinating the coarsest of the moss should be gradually removed, and when the seed is fairly up a slight sifting of fresh soil among the young seedlings will help to strengthen them. As soon as they have made the first rough leaf they should be pricked off thickly in boxes or pans of fresh soil prepared as for the seed, carefully syringed, and kept growing in a high temperature and moist atmosphere. Such delicate seedlings as rhododendrons at this stage should never be transplanted in a shed or room where there is any draught, but always in the close, moist atmosphere they are grown in, as the roots are so delicate that only a moment's drying makes them almost worthless. After five or six weeks the plants will have covered the surface of the ground in the boxes, when they will again need transplanting, this time half an inch apart, and to be otherwise treated the same as before, always being sure to use fresh soil and clean boxes at each transplanting. At this stage, if everything has been carefully attended to, they will grow very rapidly, and will need transplanting the third time, and, if properly cared for, they will need to be planted two inches or more apart.

This frequent transplanting in fresh soil each time keeps the plants from damping and also forms the foundation of a

vigorous plant for the future. If rhododendron seedlings are left long in the seed box or pan they are apt to be attacked by a minute fungus, which will often carry off thousands in a night. The best remedy I have found to check it is, at the first signs of its appearance, to heat a shovelful of sand quite hot, and sift it amongst the young seedlings, using a very fine sieve. Many would think that it would destroy the plants at this tender age, but it does not; I have tried it on almost all kinds of young seedlings, and have found it very effective in destroying the minute fungus which is such a pest among young plants. About the first of September more air and less moisture may be given, so as to harden the plants off preparatory to their removal to winter quarters, which should be a deep frame or pit in some sheltered situation. They may be put in this pit the first of October, or sooner if you need the house for other purposes. In this pit they should have plenty of air every pleasant day, but should be covered every night, to keep them from frost as long as possible. This can readily be done in most seasons up to the middle of December or the first of January by a single mat; they can then be covered with mats or meadow hay, and will only need to be uncovered once every two weeks for an hour or so, to guard against damp or excessive moisture, which will often cause a fungus, even in a cold pit, if kept long without air. In the spring, about the first of May, they can be transplanted into well-prepared beds of peaty soil, or a light, sandy loam of good depth. If dry weather sets in they will require plenty of water, as they are not deep-rooted at this time; if water is handy, I give them a good syringing every evening as soon as the sun begins to leave the bed, until the middle of August, when I withhold all moisture, so that the plants may ripen well before winter sets in. If they have been well cared for they will be from six to seven inches high at the end of the second season.

At the approach of cold weather a slight covering of leaves between the young plants, and covering the tops with pine boughs or coarse meadow hay, to keep the sun off, will carry the plants through the winter in safety. The following spring they may be planted in the nursery, where they can

remain until used. The same treatment will apply to Azaleas, Kalmias, and other Ericaceous plants, only the Azaleas grow much more rapidly than the others, and at the end of the second season such species as *mollis* and *calendulacea* will have quite a number of flower-buds on them, while the Rhododendrons will scarcely show signs of flowering until the fourth or fifth year.

[Extract from Transactions of the Mass. Horticultural Society.]

HEATING GREENHOUSES.

By JOSEPH H. WOODFORD, Newton.

I will say, in the first place, that simplicity and economy in the construction of heating apparatus have not yet been evolved from the minds of inventors to an extent sufficient to enable them to produce a simple, cheap, and at the same time efficient boiler for heating greenhouses by either hot water or steam.

Any one would suppose that, with the great demand as a stimulator, and the wonderful facilities within the reach of inventors, some one of them would have turned his attention to this want of the horticulturist, and would have produced, long ere this, a heating apparatus which, in its different sizes, would meet the wants of all, and of such moderate cost as not to nearly bankrupt the horticulturist before he completed his greenhouse.

In this connection I would say, that I think the horticulturist also is somewhat to blame for this state of affairs; for, when he contemplates building a greenhouse, what, as a general thing, does he do but look around and ask his neighbor what heater he is using, and then, without thought, adopt the same, or perhaps some other which some one else recommends as being superior? I know of only two horticulturists, in all my acquaintance with the craft, who are trying to improve their heating apparatus by their own handiwork; and what they are seeking for is simplicity of construction, economy of fuel, and, at the same time, efficiency.

In the one case a bank of horizontal pipes, surmounted by a coil of pipe, and all surrounded by brickwork, does good

service, but with great waste of heat, which passes away up chimney, and ought not to be allowed to escape without doing service.

This waste heat might be used in heating water for watering plants, by placing in the chimney, in such a manner as not to interfere with the draught, a stack of pipe, through which the water should pass before using. This would be economy in the use of fuel, for we all know that a great quantity of heat passes off up the chimney which does no work and is wasted. . Some authorities, who have looked into this important subject, say that half of all the heat, generated in or under the best of our horticultural heating apparatus, passes off without doing any good except to help heat up all out-doors. If we could build a fire which would last all night, and at the same time be of just sufficient intensity to properly heat the water in our boiler, there would still remain the same appreciable waste of heat. But even this cannot be done; and the question comes up, for that reason yet more exigently, what can be done with the heat that has been generated but not utilized under the boiler, and is on its way up the chimney? If we cannot use this waste heat in any other way, I think my suggestion of a coil of pipe in the chimney a good one, where forced water is used, for all the water passing through it would become warmed to such a degree as to make it much more acceptable to growing plants than cold water, direct from the service-pipe or cistern.

The other gentleman to whom I alluded has constructed with his own hands a bank of pipe, with the ends built into the surrounding brickwork and a fire-box underneath. The construction is faulty, and not to be recommended. On the top of the brickwork he has inclosed another space, through which he carries the water-pipe to irrigate his growing crops. No doubt this last process will be beneficial, yet by it he does not utilize the waste heat, but is drawing constantly from the heated furnace. Therefore I am of the opinion that he would get still better results by carrying the irrigating water through a coil of pipes in the chimney. We all know that the temperature of a greenhouse can readily be reduced, and the growth of plants sadly checked, by the

promiscuous introduction of cold water; and, therefore, we see the necessity of providing an economical means of supplying only warm water to growing plants.

Taking the foregoing remarks as a basis for my superstructure, I would further say, that a greenhouse heater should be constructed on scientific principles, such as shall secure adaptability for the purpose for which it is intended, together with simplicity of construction and ease of getting at it for cleaning and repairs.

Under the first proposition we will say that the method of heating greenhouses by pipes conveying either hot water or steam is now conceded to be the best in use, and this presents the vital question: How can we heat water most economically and most expeditiously? Shall we continue, blindly, to use those boilers which are constructed in such a manner as to present to the fire a great mass of water in one solid body to be heated, or shall our boiler be constructed of pipes whereby the same body of water shall be exposed to the warming influence in small streams, and with augmented heating surface in the same space?

It strikes me that the same fire will heat the same quantity of water if divided in small tubes much more quickly, and to a more intense heat, than if in one body. Now, it is an established fact, that the hotter water can be made in the boiler, the faster it will circulate through the pipes, and in this way, and this only, can a large space be heated either by hot water or steam. This point is worthy of close study and careful consideration, for the end to be attained by the horticulturist is the successful growing of plants, and to do this properly, in our cold winter climate, heat in requisite amount must be supplied all over the greenhouse, to produce the temperature required for the crop; and the only way to have at command proper temperature is to be able to heat the water in the boiler quickly.

Now, it seems to me that, for a successful heating apparatus, the water must be presented to the fire in such small, *continuous* divisions that it will become hot in the shortest space of time possible; therefore, I would have my boiler constructed of tubes, and placed over the fire in such a manner that the greatest possible surface of pipe will be exposed

to the heat before the heat shall pass off up the chimney and be lost. The construction can be very simple, and not expensive. For example: A bank of 1½-inch pipe, occupying a space 5 feet long, 2 feet high, and 2 feet wide, bridged in the middle by tiles, so that the heat from the fire built under one end shall pass through the bank twice before reaching the chimney. Let the bank of pipe be enclosed in brickwork, the top of this brickwork resting on gas-pipe bearings. The whole structure should project into the greenhouse, thereby saving all the heat radiated from the furnace. The feed door should be outside, to prevent coal gas from entering the greenhouse while stoking. This plan will make a fire-box 2 feet wide by 2 feet long, which would be sufficient for heating two greenhouses 100 feet long by 20 feet wide. The water is to pass in at the bottom of the bank of pipe, and out at the top, thus being in *one* continuous small stream of one hundred feet long through the bank of pipes.

The flow of water in one stream through such a length of pipe (one hundred feet), and over a live fire, ought to heat the water very hot in a short space of time, thereby making it flow through the radiating pipes with such velocity as to cause its rapid return to the boiler after giving off its heat as required. This is the great secret of successful heating, and I ask for it your most careful consideration; for, with a higher initial temperature and rapid circulation, we shall not require such large radiating pipes as four inches to heat our greenhouses, nor so many of them; for what we require to properly do the work will be kept very hot, even in the return section, by the constant and rapid passing of the current through the fire in one continuous small stream.

I would construct the flow-pipe in such a manner, as it passes from the boiler, as to immediately empty itself into a stand or expansion pipe near the boiler, and on the top of this stand-pipe I would have a valve which would open under a definite pressure, liable to be generated in case of the great heat in the water inducing steam and otherwise entailing an explosion.

Some persons — and I am one of them — assume to say that the accumulation of steam in this stand-pipe will act as

a force, provided the valve is weighted, propelling the hot water through the radiating pipes, thereby very much increasing its natural velocity, and returning it again to the boiler before it loses its heat. I cannot say, from actual experience, whether this stand-pipe will act as a force or not, but am confident it will so act, and that this theory will stand the tests of science and experience against any other theory.

I have never yet seen the expansion-pipe thus placed near the boiler; yet, when we reflect on the action of hot water and steam, it seems to me that this is the proper place for it, and I hope that the plan I now propose will so commend itself to some enterprising horticulturist that it will be tried at once, for I believe that in this way, and this only, can we accelerate the flow of hot water; and therein lies the whole secret of successful heating. I conceive that this stand-pipe can be placed in such a position in the greenhouse, and the flow can be taken from it at such a depression as to preclude the necessity of placing the boiler below the level of the surface of soil in the greenhouse. This is another very important point in construction, and is worthy of great attention. Every boiler-pit I know of is a dark, damp hole, exceedingly objectionable in every possible way, often filled with water, and disagreeable to enter. But, with the method of construction I suggest, the whole arrangement will be on the surface of the ground, and the care of the fire can be looked at as a pleasure rather than a dread.

The chimney should receive the smoke on a level with the grate, or lower down, so that all the gases from the coal will be consumed over the fire and among the pipes constituting the boiler.

The radiating pipes in the greenhouse are to be in number sufficient to properly heat the space required, *and no more.* To have more than enough pipes is detrimental, because the surplus causes the water to move sluggishly, whereas our object is velocity, and this can only be attained with the least quantity of pipes to accomplish the proper heating.

Another very important point in construction is, that the radiating pipes should be *continuous* and without a break till they again reach the end of the greenhouse where the boiler

is situated, gradually falling to this point so that no air will remain at any point in the pipes when filled with water.

A single pipe will cross the entrance end of the greenhouse on a level with the door-sill, conducting the water directly to the boiler, thus making a continuous circulation.

The radiating pipes should be four in number, two inches in diameter, of wrought-iron, with screw-joints. They should be painted black with a preparation of oil and lamp-black, for when they are so painted they radiate more heat than if left in their natural state, and they are also preserved from rust by this application of paint. They should also be hung up one above the other around the inside of the greenhouse clear of the woodwork and the ground, so that all the heat radiated from the pipes will go to heat the air in the house, instead of being absorbed by contact with exterior masses.

A greenhouse 100 feet long, 20 feet wide, and 10 feet high under the ridge-pole, built half-span roof, with the longest roof facing south, will require about 900 feet in length of 2-inch wrought iron pipe. This would give a radiating surface of about 590 square feet, amply sufficient to properly heat the house I describe. The glass surface will be about 2,300 square feet, and the solid contents of house about 15,000 cubic feet. The quantity of water in the boiler and radiating pipes would be about 130 gallons.

I wish to say a word in regard to the construction of the grate under my boiler. I would make it of 1½-inch gas-pipe, leading from a 4-inch pipe-head, which head can be extended to take in fresh air. This fresh air will pass through the grate into a conductor placed along one side of the greenhouse under the radiating pipes. This conductor can be constructed of old 4-inch pipes, perforated with graduated holes the whole length for the equal distribution of warmed air into the greenhouse.

This is quite a novel idea, but one which will, I think, commend itself to you as feasible, when you once reflect on the quantity of heat wasted in the ash-pit, and which will be made to contribute to heating the grate-bar pipes, through which a great quantity of air must pass when these pipes are hot. At all times this grate will indirectly introduce a sup-

ply of fresh air to the house, and in quantity sufficient to keep the air in the house alive and sweet, without the necessity of opening ventilators in dull and unsuitable weather. I do not know of so good a manner to introduce fresh air to a greenhouse as this, and at so little expense to the heating apparatus by the absorption of heat.

There should be doors so constructed in one side of the brickwork as to enable one readily to inspect the pipes, and to keep them free from ashes and dust that will lodge upon them. Ashes and dust on boiler-pipes act as a repellent to the heat, thereby causing great waste of fuel, for it takes a great deal hotter fire to heat dirty pipes than clean ones.

Such a construction as I have tried to describe, it seems to me, will do more heating with less expense of fuel than the very much more expensive apparatus now used in nearly every greenhouse in this section of country can possibly do; and as it is simple in detail, easily comprehended, and not liable to get out of order, I confidently commend it to you as the *best* heating apparatus for a greenhouse.

I sincerely hope that my few remarks will stir up a discussion of the subject which will only end when we accomplish the purpose for which we are assembled, and that is to devise a cheap and economical way of heating greenhouses.

Since writing out the foregoing remarks, I have had my attention called to another gentleman, Mr. George Cartwright, who has been quietly at work with this same end in view (the economical heating of his greenhouse), and, singularly enough, he has adopted some of my most important suggestions, and they work most admirably. He has his stand-pipe close to the boiler; but in one point it is not constructed as I have proposed, inasmuch as the water from his boiler enters the stand-pipe at the bottom, whereas, in my construction, it enters about mid-way; and I think my method best, as it seems to obviate a part of the water pressure from the stand-pipe on the boiler.

Mr. Cartwright's boiler is cylindrical, and it is also the fire-box, open at the top and bottom, and resting on fire-bricks just above a shake-grate, and the coal is fed in at this top of the cylinder. When he starts the fire a direct draught is opened into the chimney; but when the fire is

well alight the direct draught is closed, and the heat passes over the top edge of the fire-box and water-jacket, down the outside, all round, and enters the chimney below the boiler. In this way he gets nearly all the good of his fire in heating water in the boiler or jacket. His copper boiler is $2\frac{1}{2}$ feet high by 16 or 18 inches diameter, and he heats a house 180 feet long by 15 feet wide with five 2-inch pipes.

This idea of heating water under pressure was first brought to my attention by Mr. Denys Zirngiebel, who has it in successful operation at his place in Needham. And now I learn that Mr. A. P. Calder has adopted the same plan, and, if he is present, will tell us of his success. Before I put any thought into this subject I never supposed that water could be heated much hotter than the steam point; and it cannot if it is not confined; but when you once confine it and apply heat you can bring it to almost any high temperature you desire, therefore you will readily see that large spaces can be heated more quickly when pressure is used. I know of a great number of greenhouse men who are warming their houses by trying to heat from twelve hundred to fifteen hundred gallons of water with a jacket boiler surrounding a fire, but with the boiler exposed to the damp air of the stoking-pit. In some instances they begin an intense fire at noon, and keep it up till ten o'clock at night, melting the coal into clinkers, wasting great quantities of heat and causing great anxiety. A gentle continuous fire under my boiler will keep the water always hot, and can be kept in the proper condition, when a cold night overtakes one, to immediately respond to a good stoking, and carry the temperature to a point to allay all anxiety, so that one can rest in peace.

Heating greenhouses is very similar to heating dwelling-houses. Some people think that if the cold-air box is wide open a great amount of heat is sure to enter the rooms, whereas the opposite is the result; and the inmates of those houses are cold, and often remark that the furnace is not a good one. Now, if some one would kindly close the air-box down to a space six inches square, all the air coming through such a space would be warmed, and the furnace pronounced a good one. Just the same experience happens with radiating pipes in the greenhouse; two-inch pipes can

be kept very hot with an ordinary fire, such as would only just warm four-inch pipes; therefore I would caution horticulturists not to put in more pipes than they can properly heat very hot, for when we get more than can be so heated we are throwing away fuel, and jeopardizing our plants.

Discussion.

E. W. Wood was called on by the president, and said that he was only a learner, and had never seen a heating apparatus of the kind described in operation. If we can get a more rapid circulation, and less fire will keep it up, that is an advantage; but at present he goes to bed with more confidence than if he had only two-inch pipes in his greenhouse. Nothing retains heat better than water. He replenishes his fire at three P M., and banks it at seven. A cold, windy night like the last night makes it very difficult to keep a proper temperature in the greenhouse. He would rather have it 10° below zero and still, than 15° above and windy. He does not think so much heat is lost up the chimney as he formerly did; it does not amount to much except while the draught is open to start the fire. A neighbor who thought, from his chimney being so hot, that a great deal of heat was lost through it, ran it up the length of a house on a side hill; and although very hot while he was making the fire, shortly afterwards it was nearly as cold as if there had been no fire in it.

James Cartwright had known a boiler tried with a brick partition, as recommended by the essayist, which was afterwards taken out and a plate of iron was inserted, so placed as to avoid a downward draught, and it did better. He would prefer to have a dividing partition horizontal rather than vertical, as his experience had shown that it would work better; and it is better not to have a flue dip downwards. He thought a boiler built of pipes, as recommended by the essayist, should have them connected at both ends by means of a box or drum, instead of by returning bends in the pipe, which would make too much friction and obstruct circulation through the boiler, so that there would be danger of the pipes being cold in the morning. He thought a boiler built on the plan recommended should be from eight to twelve

feet long: five feet would be too short. The stand-pipe was correctly placed near the boiler; when too remote the boiler will sometimes make steam and throw the water out of the stand-pipe, and then when the steam subsides the pipes will not be full and the circulation will stop. His son (Mr. George Cartwright, who was mentioned by the essayist) has his flow-pipe dropping to the end of the house, and the return-pipe dropping also; and he uses less fuel than with large pipes. The return-pipe is hot enough in the morning to burn your hand. If you get water very hot, with bell joints, there is danger of their opening, but with screw-joints you can go to bed and feel safe. He uses a copper boiler two and one-half feet deep, with a fire-pot twenty-two inches in diameter, and carries about ten pounds' pressure; and is now heating a house by means of five two-inch pipes with greater ease than formerly, when he used seven four-inch pipes, and it takes less coal to do it. He thought a copper boiler would wear better than an iron one over a coal fire.

Mr. Woodford said that in his plan the pipes go round the house and into the boiler.

Col. Henry W. Wilson said that there are certain axioms in heating, and the best way known to scientific men for heating water is the best for horticulturists. Great ingenuity has been expended on apparatus for heating cars. The scheme proposed by the essayist has been gone over before, and it has been found that you cannot get a draught with a large chamber and a small aperture. You cannot ventilate a room by an opening into one above it. A vertical boiler is preferable to a horizontal, for all the motive of circulation is the difference in the specific gravity of hot and cold water. If water is heated you want to give it as rapid a vertical motion as possible. Friction in large pipes is less in proportion than in small pipes. Iron is not so good a material as copper or brass for a boiler, though its greater cheapness makes its use more general. Copper is a far better conductor of heat than iron. Iron is a poor conductor; if a perfect conductor be rated as 100, iron will rate as 14. The thinner the pipe is the better, so far as regards the conduction of heat. Cast iron, as being thicker than wrought iron, is not so good, but is preferred, because less subject to rust.

Water itself is a very poor conductor of heat, but is able to absorb and retain a very large amount; which can be carried, by convection, to a considerable distance from the fire, — hence its value as a circulating medium. Lampblack makes an excellent paint for radiating pipes, causing more rapid radiation, which is the reverse of absorption. The radiation of lampblack is to that of iron as 100 is to 64. A tin dipper filled with hot water, if black, loses heat twice as fast as if bright.

Mr. Woodford said that he would put on a pressure of ten pounds to promote the circulation.

Col. Wilson said that the best car-heaters have no pressure. Mr. Woodford is right in placing the stand-pipe near the boiler. The expansion of a thousand gallons of water caused by heating to 212° would fill a barrel. With a vertical partition in the stand-pipe, it would work twenty-five per cent. better. The only advantage in running a water circulation under pressure is to be found in the slightly higher temperature which can be gained. Pressure is solely from the effect of steam. A pressure of five pounds to an inch, equal to about eleven feet head of water, would raise the temperature of the water when boiling to 238°, instead of 212° as in the case of open pipes. When we run under pressure we require stronger apparatus and tighter joints; and, if pressure were to be used at all, he would prefer steam, which is very easily managed. There will be a tendency to form globules of steam, which will rise in vertical pipes, and every particle must be replaced by the return-pipe. You cannot heat pipes by the plan of the essayist: there would be no heat in the two lower pipes; the water will take the shortest route to return. The most intense heat applied to the surface will not heat water a foot below it.

The speaker formerly objected to steam, but has modified his opinion in regard to it. He spoke of George Hill's house, at Arlington, as one which it would repay all interested to visit. Mr. Hill has the newest arrangements, and one foot of surface of the steam-pipes heats thirty cubic feet of the greenhouse. He has an upright boiler, which is the best heating unit, and the steam goes to the end of the house, and returns by six pipes an inch and a quarter in

diameter. He uses a pressure of one pound to the square inch. There is a compensating valve by which a uniform pressure, equal to 215°, can be maintained for ten hours during sudden and severe changes of weather. The pressure could be increased if desirable; but it is not. The adjustment is simple and automatic. One of the advantages of steam over water is that it takes but very little time to heat up or to cool off the pipes, and, with good apparatus in good hands, it is more easily managed than hot water. Another advantage is, that steam affords the easiest way to moisten the air of the house when too dry; which is a protection against freezing in cold weather. A house will cool off more quickly if the air is dry than if moist, because the capacity of moist air for heat is three times as great as that of dry air.

The study of this subject will be more profitable to the owners of greenhouses than that of any other; indeed, it has an application to every part of life. Some kinds of glass will transmit the heat of the sun better than others. Great care is needed in the selection of glass for greenhouses. Any one wishing to understand the very complex questions offered by the subject of heating would do well to study the work of Professor Tyndall on heat. He is the best authority, and his experiments can be tried by anybody.

Mr. Woodford said that Mr. Zirngiebel's houses were the first he ever saw heated under pressure. He has four houses heated by one boiler, the expansion-pipe being a hundred feet from the boiler. The furnace is like that recommended in the essay, though he could not say about the partition, but it has a coil of pipe, like a beehive, on top. An arm runs to each of the four houses, and they are heated better than any others of his houses. The whole of the water in them moves. He has a ventilator, which he opens, so that the chimney is cold. The speaker could not understand why the two lower pipes in the plan proposed by him should be cold. In this plan the furnace fire goes up and afterwards down.

William C. Strong thought that the use of steam would be more general in future, especially in large establishments where several houses are to be heated from one fire.

William D. Philbrick remarked that there seemed to be some confusion of ideas with some of the speakers in regard to the use of pressure in hot-water circulation; its only advantage is in the higher temperature which can be given to the pipes; it does not render friction less or circulation more rapid, and is objectionable on account of the greater difficulty in keeping the pipes tight. If pressure is used, there must be a safety-valve on the stand-pipe or elsewhere. It is possible, under high draught on a windy night, for the water to boil over and be thrown out, so as to leave the upper part of the circulating pipes full of air and steam, which would obstruct the circulation. If he wanted pressure he would prefer steam. Mr. Hill's apparatus works perfectly.

Mr. Woodford spoke of the advantage of a greater quantity of water than is found in steam pipes.

Col. Wilson said that this advantage would not exist if the arrangements were properly made. Mr. Hill's house was kept at a temperature of 40° when the thermometer outside showed 15° below zero. The adjustment is simple and automatic, a variation of one ounce per square inch in the pressure changing the regulator; and it obviates the objections previously made against steam. The speaker knows you can send ten times the heat through pipes with steam that you can with water.

Mr. Wood said that he has a steam-heater in his dwelling-house, and though he has an automatic arrangement, he burns twice the coal there that he does in his greenhouse with hot water. He thought the slowness with which large water pipes cool off when the fire goes out an advantage, but steam pipes get cool in fifteen minutes; and you have got to have a certain amount of heat to get steam. He makes up the fire in his greenhouse at three o'clock, and at seven leaves the draught slightly open. Mr. Hill grows cucumbers in his house, and these require more heat than the plants in the speaker's greenhouse.

George Hill said that this was his first winter with his steam-heating apparatus. He looked at a neighbor's which was satisfactory, and put in the same sized boiler. His house is one hundred and sixty-three feet by twenty, with

the boiler at one end. The steam flows in a two-inch pipe and returns in six pipes an inch and a quarter each. He can get up steam with wood in fifteen or twenty minutes. Last December, when the thermometer was at 15° below zero, he fired up at eleven P.M., and gave no more fuel until nine A.M., and the temperature did not vary more than two or three degrees from fifty, without any attention. This morning (which was very cold for the season) the thermometer in this house was up to sixty, and he had to open the windows and admit air. Nothing more would be required until two or three P.M. In a cold morning the coal is exhausted more than in mild weather, when the damper is closed. He uses a cast-iron sectional boiler, under one pound pressure. He thought it would not be long before we could run a house from six to twenty-four hours by an automatic arrangement. His house is on a side hill, and he thinks of putting up another. He might lose some heat up the chimney. With hot-water pipes, if the sun comes out, the large body of heat in the water is wasted.

Mr. Woodford said that opening the windows directly against the pipes and letting in the air would cool off the pipes.

Mr. Strong said that it is a very serious evil, when the sun comes out, to have a great body of hot water in the pipes. He has felt that we extracted more of the caloric from the fuel in furnaces surrounded by water pipes than when steam is used; and thought that with vertical boilers a great deal of the heat went up the chimney.

Col. Wilson said that the steam fire-engine is the most perfect generator of steam; it will heat up in five minutes. Mr. Hill's boiler requires only fifteen minutes. Steam travels with great rapidity. The speaker predicted that the coming boiler will be small, with the amount of water reduced to the minimum. Water-pipes will rust, and you are gone. He used a three-inch wrought-iron pipe for hot water eight years, and it was so filled with rust that you could not see through it. Cast iron will not rust so badly as wrought iron. Asphaltum is a poor conductor; but it might pay to coat hot-water pipes with it to prevent rust. It has been proposed to use crude petroleum as a heating medium instead of water,

but it would be dangerous to introduce it into pipes, for it contains water, which the heat would evaporate. Besides, the inflammable vapors of petroleum are heavier than the air, and if they escaped from the stand pipe would flow to the fire-room and cause explosions.

Levi W. Hastings said that he has had no experience with hot water, but has used a steam boiler like Mr. Hill's, but larger, for the last three years and found it satisfactory. He raises chiefly roses and pinks. He has four houses, each one hundred feet long, two of which are ten feet wide, one eighteen, and one twenty; making six thousand square feet, with span roofs, all heated by one boiler. If you heat by means of water, and get up in a cold night and find the pipes cold, it takes a good while to warm up; but he can get up steam in fifteen or twenty minutes. His boiler works automatically; he puts on a three-pound weight at night, and gets up at six in the morning, and finds a pound pressure. He uses about forty tons of coal in a season. He used from fifteen to seventeen tons in the first house, and then added two more houses and used thirty-five tons. The boiler did not work well, and he put in a larger one, and he thinks he could run double the number of houses he has now with ten tons more of coal.

[Extract from Transactions of the Mass. Horticultural Society.]

A COMPARISON OF MANURES FOR THE GARDEN AND ORCHARD.

By PROFESSOR G. C. CALDWELL, Ithaca, N. Y.

How to manure the garden or the orchard for the most profitable results is one of the most difficult questions that the horticulturist has to meet. Of the biggest and most solid cabbages, the earliest pease, the largest squashes, the sweetest and most prolific berries, the handsomest and most delicately flavored grapes, the most luscious peaches or pears, the earliest or the best late-keeping apples, he has an unlimited variety offered him by all the seedsmen or nurserymen in the land; and he need find no difficulty whatever in laying out to good advantage all the money he has to spare for use in this direction. Of the most suitable land on which to plant all these crops there is enough and to spare somewhere in all this wide country. Of tools and labor-saving machines of every kind, and of men and animals to run or to use them, there is no scarcity. In respect to all these supplies there is only embarrassment of riches; and no crop need fail of producing good fruit abundantly, from any want of liberal provision for its highest requirements on any of these lines.

But is there such a superabundance of supply, when we come to the matter of the highest requirements as to the food for these crops? Is there a sufficiency of a supply of such kinds of food as will, in the general run of garden and fruit culture, give the surest results? Is not the gardener's call always for more stable manure? and is the call of the fruit grower any less loud? One naturally asks, why is this so, when there are, elsewhere at least, immense if not inexhaustible quantities of the nitrogen, phosphoric acid and

potash, that are reckoned as so important plant nutrients, all to be had for the purchasing, and under so great competition that they ought to be had for as low rates as they can be sold for, paying fair profits. They can be had also in every form of combination, and every degree of assimilability, and in any desired mixture; and, further, to save the farmer or the gardener the trouble of studying out for himself the kind of combination that his crop needs, mixtures are offered to him, ready made up, for each crop.

Abundant as these commercial supplies are, they do not seem fully to answer the purpose; for I doubt if the demand for animal manures is any less urgent now than it was before commercial manures became the important articles of trade that they now are. Yet, in agricultural operations, superphosphates, bone meal, nitrate of soda, and the like, have, in some few cases, been made to take the place, entirely, of stable manure, with profit.

Perhaps you have heard the history of Mr. Prout's farm in England. Mr. Prout bought this farm in 1861; it comprised four hundred and fifty acres, and its cultivation in the manner to be described was, therefore, no small plot experiment. It was, when taken in hand, in a low condition of fertility; the owner asked the aid of the eminent agricultural chemist of England, the late Dr. Voelcker, as to the best way to bring the farm into good condition again. The advice was to dress it well with stable manure. After doing this with unsatisfactory results for two years, application was again made to the chemist, who told the owner to use more stable manure; he said he could not afford it; then the chemist visited the farm again, examined it carefully, and suggested the use of commercial fertilizers after a certain plan. The plan was followed, and bone dust, superphosphate, dissolved guano and nitrate of soda were the only manures used from that time on. The crops — clover, hay, grain, straw, and everything — were all sold standing; only an insignificant quantity of manure was made, the cultivation being almost entirely by steam. This system has now been carried on for more than twenty years. The estate cost the purchaser in the beginning, $74,500; enough more was spent upon it in improvements to make the total

cost about $100,000. The annual clear profits have been, on an average, about $4,500; and it was estimated that the farm could be sold, eight years after it was taken, for twice what it had cost. Last fall the crops were reported in the "English Agricultural Gazette" as looking well, and the system was spoken of as continuing to succeed, although with the qualification that some fallows had been found necessary.

This is not the only instance on record of this kind of farming. Other cases have been reported where the system has been followed for forty years, in Germany. I give these few details in regard to this one instance merely to show what can be done with commercial manures when intelligently used, — to show that they do contain all the food required by crops, — and that, with their assistance only, a farm can be brought up from a low condition to a higher one, and held there for a series of years; and no one can show that what is true of farm crops should not be true of garden and fruit crops as well, — if not to the same extent, yet to a large extent. They feed on the same kinds of soil, and in the same manner, and require the same nutrients in general; and the same particular nutrients that are specially important for farm crops are, so far as we know, specially important for garden and fruit crops. The proportions required may be different, but perhaps not more so than they are even for different farm crops; the same mixture of nitrogen compounds, phosphate and potash salts will not answer equally well for wheat and for potatoes, nor even for wheat and for corn, which are more nearly alike than wheat and potatoes.

What are the obstacles in the way of the more extensive use of commercial fertilizers in the garden and fruit orchard, and of less dependence on the products of the city and village stables? In answering this question we naturally ask, first, what does stable manure contain that is not supplied in commercial fertilizers?

The valuation of a commercial fertilizer in the trade is based, as you know, on the quantities of nitrogen, phosphoric acid and potash that it contains, — some fertilizers containing only one of these nutrients, others two, and

others all three of them. There is no question that in respect to just these nutrients we can meet the wants of any crop better by supplying commercial fertilizers than we can by stable manure, if there is any difference between the two as to efficiency. But, besides these, the crop must find in the soil, supplied from some source, lime, magnesia, sulphuric acid in the form of sulphates, of which plaster is one, a very little iron, possibly chlorides, of which common salt is one, and, perhaps, silica. Every superphosphate contains an abundance of lime and of sulphuric acid. The muriate of potash, brought from Germany, is a chloride, and contains chlorine. Of iron every soil has an abundance, many thousand times more than any crop needs; and the same is true of silica; of magnesia there is enough to be had in the German kainite. But as to all of these nutrients last mentioned, — sulphate, chloride, silica, iron and magnesia, — there is no proof that the average soil is not abundantly rich in them for the production of good crops. Hence it is that we are justified in charging all the cost of a commercial manure to, and in expecting to get our money back from, its nitrogen, phosphoric acid and potash; the rest of the ingredients must be thrown in gratis, as of no value generally, although there may be cases where one or another of them may be of some service. All of these matters the stable manure also contains in abundance.

So far no one can claim anything for the stable manure that is not supplied by the commercial fertilizer. The only respect in which the two materials are distinctly unlike is this: the stable manure is composed largely of dead vegetable and animal matters in process of decay; the product of this decay is the humus or vegetable mould of the soil. About one-fifth of ordinary stable manure is made up of this vegetable and animal matter, while not over six to eight thousandths is potash, five or six thousandths nitrogen, and three thousandths phosphoric acid. Of nitrate of soda, so much mentioned as a very useful fertilizer for its nitrogen, one-sixth is this nitrogen. Of a good superphosphate, as this fertilizer averages in this country, about one-eighth is phosphoric acid; and if one desires it, and is willing to pay for it, he can have a superphosphate with one-third its weight of phos-

phoric acid ; of a German muriate of potash from a third to a half may be potash. But in all these materials there is no vegetable matter, and little or no animal matter.

Here, then, is a clear distinction between the two kinds of manure, the stable and the artificial : the stable manure has its few thousandths of nitrogen, of phosphoric acid, and of potash, and its one-fifth of decaying vegetable and animal matter ; the commercial manure only its few thousandths or even less of animal matter, and its proportions of nitrogen, phosphoric acid and potash counted by eighths to thirds. About three-fourths of the stable manure is only water, however ; expel this, and get a manure as dry as commercial manures ordinarily are, and the comparison between the two will be more just and no less striking ; we shall then see that four-fifths of this dry manure is decaying vegetable and animal matter, about one-fortieth is potash, one-eightieth phosphoric acid, and one-fiftieth nitrogen.

Can any way be now shown in which this striking difference between the two kinds of manure may account for the greater measure of success that is attained in general with the stable manure?

As already said, decaying vegetable or animal matter in the soil makes humus, or vegetable mould. This common ingredient of all arable soils is not necessary for plant growth ; for, on a small scale, in pot culture good crops have been obtained in a soil as white as snow, and therefore quite free from any humus, but containing all the real plant nutrients that have been mentioned. But that this humus is an important ingredient of a fertile soil no one can doubt. Given two soils equally rich in nitrogen, potash, phosphoric acid, lime, and all such matters, but of which one is poor in humus and the other rich in it, but yet not so excessively rich as a bog or a muck bed, there is not a farmer or gardener who knows soils who would not give more for the soil rich in humus than for the other. In the course of the decay of these vegetable matters several acid substances are formed, and chiefly carbonic acid. These acids act on the large quantity of difficultly soluble plant food in every arable soil of fair quality, and aid in bringing it into solution, and thus within easy reach of the plant. Few farmers realize what a

large native stock of crop food they have in their soils. In the case of a fertile soil from a Western State, analyzed some time ago in Germany, there would be, by calculation from the analysis, in one acre of it, and within a foot from the surface, 2,400 pounds of phosphoric acid and 7,000 pounds of potash. But nobody in New England has a Western prairie soil on his farm; nevertheless, judging from analyses of twenty-five different soils of average quality by the same chemist, we may say that an average good soil will contain, within twelve inches from the surface, and therefore accessible to the crops, and fit for plant food if any means can be provided for bringing it into solution, 1,500 pounds of phosphoric acid, 1,500 pounds of potash, and over 1,750 pounds of lime. Compare these amounts with those that a crop takes up, and one can realize more fully the native value of a good soil. The quantities of phosphoric acid and potash in pounds, per acre, required by some of the more common crops are shown in the following table: —

	Phosphoric Acid.	Potash.
Corn, 50 bushels and its stover, . .	50	70
Potatoes, 150 bushels, ...	15	50
Wheat, 25 bushels and straw, . . .	18	25
Apples, ...	20	50

These native supplies, then, so very much larger than the yearly demands of the crops, if we can bring them into use only a little every year, may go far towards producing these crops for the farmer or gardener. If humus by its decay helps to bring about the solution of these supplies, then it must be useful, since all such plant food must be taken up in solution.

That the carbonic acid, which is one of the main products of the decay of humus, does in some way favor vegetable growth is very neatly illustrated by an experiment performed many years ago by Stoeckhardt. Three deep glass vessels, two of which had holes pierced through the bottom, were filled with soil, and peas were planted. Through the hole in the bottom of one of the vessels, and up through the soil, there was passed every day a certain quantity of air, and up through the soil of another of the vessels a mixture of air

and carbonic acid; the third vessel was left to itself, and the condition of things in it was about the same as in an ordinary soil with a very compact and impervious subsoil. The weight of dried crop produced in the third vessel without any circulation of air was about 90 grains; in the soil through which air was circulated, 162 grains; and in the soil through which air and carbonic acid were circulated, 190 grains. In some way the carbonic acid along with the air helped the crop amazingly, more than doubling it. This was not necessarily because the plant fed on this carbonic acid directly, to supply itself with that most important element, carbon. It has been proved, over and over again, that vegetation supplies itself with carbon, at least mostly, if not entirely, from the carbonic acid of the atmosphere. The fair presumption is that the carbonic acid passed through the soil brought more plant food into solution, and so the crop was more liberally provided with this means of growth.

In support of this presumption we have the fact, demonstrated also by Stoeckhardt, that the very soil which produced the largest crop, and therefore had yielded up the largest amount of dissolved plant food, still contained the largest amount of soluble plant food, ready for the next crop. The quantity of such soluble food was, in the soil of the closed cylinder without any circulation of air, 22 grains; in the cylinder furnished only with air, 43 grains; and in the soil to which both air and carbonic acid were supplied, 60 grains.

You will have noticed that the second soil, receiving only air, also gave a notable increase both of crop and of soluble plant food left for the next crop. On first thought this result would appear to conflict with the explanation given of the increased crop in the third soil, that it was due to the carbonic acid passed through that soil along with the air. But there is not necessarily disagreement here; it is quite reasonable to suppose that the humus in this soil, together with the oxygen of the air that was circulated freely through it, produced the same effect, and in the same way, as was produced by the carbonic acid ready formed in the third soil. The formation of carbonic acid from the humus can

take place only in the presence of oxygen, and the more liberal the supply of oxygen the larger will be the production of carbonic acid from a given quantity of humus. In this second soil we had, as in all the others, the ordinary quantity of humus; the supply of air, with its one-fifth part of oxygen, was liberal; carbonic acid must have been produced freely; and it would have been strange if there had been no increase of crop. Such a result would have tended to disprove just what we are seeking to prove, that the humus does a good work for the farmer by the carbonic acid given off in the soil as it decays, or oxidizes, which two terms mean much the same thing.

Another experiment shows in a no less striking manner the part that humus may take in bringing plant food into solution: a sample of a sandy loam was compared with another portion of the same soil to which some humus had been added; in the course of the summer months, while a crop was growing vigorously on these soils, the quantities of potash that became soluble in the two soils were as 366 parts in the soil poor in humus to 574 parts in the other; the quantities of plant substance produced in the two cases were 5,040 and 9,800 parts.

That the presence of decaying vegetable matters or of humus in the soil does increase the proportion of carbonic acid there, is fully shown by analysis of the air in the pores of the soil. The air above the soil contains 3 parts of carbonic acid in 10,000, while that in the soil may contain ordinarily 100 parts in 10,000; and, moreover, such richness in carbonic acid is found only in the air of soils containing humus. A rich dressing of stable manure, or, in other words, a large addition of decaying, humus-forming substance, largely increases the quantity of free carbonic acid in the soil. An asparagus bed that had not been manured for a year contained in the air in the pores of the soil 122 parts of carbonic acid in 10,000, but when recently manured 233 parts. Another, a surface soil rich in humus, had 540 parts of carbonic acid, a newly manured sandy field 333 parts, and the same soil in wet weather 1,413 parts, of carbonic acid in 10,000 of its air.

This function of the humus of the soil can also come into

use, with respect to the plant food added in manures. To me, one of the most interesting properties of soil is that remarkable power it has of absorbing certain valuable plant nutrients, holding them in a difficultly soluble condition near the surface, so that, however much rain may leach through the ground, they will be only very slowly carried down deeper, or washed out altogether. Thus the soil behaves with phosphoric acid, with potash, and with the ammonia that is so valuable for its nitrogen. For these three substances any arable soil that is not too sandy is a most trustworthy savings-bank. Therefore, although we should make much account in buying a fertilizer of the proportion of soluble phosphoric acid, or potash, or nitrogen compounds in it, yet, in all probability, to say the least, our crops take up but a little of these nutrients before they are changed by this fixing power of the soil into a difficultly soluble condition.

Why, then, it will naturally be asked, should we pay ten cents a pound or more for soluble phosphoric acid when we can get good insoluble acid for six cents or less, if what we put on the soil as soluble so soon becomes insoluble? For this reason, partly, that the even distribution of the food through the soil is a matter of much importance. Any one can easily understand that if a bottle of the much-advertised, and I suppose very useful tonic, Horsford's acid phosphate, were poured over half a bushel of soil, and washed in with a slight drenching of water, phosphoric acid would be far more thoroughly mixed with that soil than, by any reasonable amount of stirring, such as one could afford to give to a cultivated field, he could distribute two ounces of dry superphosphate through the same quantity of soil. So, when four hundred pounds of superphosphate are applied to an acre of soil, in spite of the best of the usual cultivation that could be given to that soil the fertilizer would remain in little scattered particles here and there; but let the rain take it into solution for a short time, and distribute it over the surfaces of many hundred thousand particles of soil, so that the feeding rootlets find it wherever they go, and how much wider and more even the mixing of the fertilizer with the soil will be, and yet, so quickly does the soil seize hold of this travelling plant food, and insolubilize it, if I may borrow a very con-

venient French word with a very plain meaning, that it cannot stray far off.

Practically, then, every crop has to procure all its phosphoric acid, all its potash, and a part at least of its nitrogen, from difficultly soluble compounds in the soil; and I think it is now easy to understand why, as so often observed, commercial fertilizers do their best work when used with stable manure: the abundance of carbonic acid generated by the fresh application of such manure assists in the re-solution of the insolubilized phosphoric acid and potash of the commercial manure, as well as of the difficultly soluble native food of the soil. Some writers consider this to be such an important function of stable manure that they condemn the practice of allowing it to rot in the yard at all; they would have all the decay go on in the field, just where the products of this decay are needed for their action on the soil. It was somewhat interesting as well as amusing, while I was writing this, to meet with the statement in an English paper, that a patent had been taken out in England for charging a soil with carbonic acid through pipes laid near the surface. A few good results of such a system would be worth more in illustration of the principle that I have been explaining than the patent will ever be worth to the inventor. No results are given, but you see that it is exactly what Stoeckhardt did, and I have no doubt that it would increase the yield of crops; but, as long as we can still get hold of any humus-forming material at reasonable rates, we have a far cheaper method of attaining the same end.

There are other ways in which humus may, and doubtless does, favor the production of crops; but, to my thinking, all of them taken together do not sum up for so much as does this one way that I have been speaking of.

We can compare stable or other animal manures in another way that may explain the reason why less satisfactory results are sometimes obtained with the latter; I refer to the comparative cost of plant food in the two kinds of manure. You are aware that the Directors of the Experiment Stations of Massachusetts, Connecticut, and New Jersey have, in the past few years, conferred together in the spring to determine what may be considered as a fair valua-

tion per pound, of nitrogen, phosphoric acid and potash, in their various degrees of solubility as found in these manures. The figures thus given represent the retail cost of these substances in the markets of the State where they are sold as raw materials to be worked up into the various brands of fertilizers offered for sale during the year.

On the basis of this scale of values adopted for 1884 I think it is fair to assume that when a gardener or a farmer buys potash in a commercial fertilizer, with the same degree of solubility and availability for plant food as in ordinary animal manures or other animal waste used for manure, he will have to pay at least five cents a pound for that potash; for phosphoric acid of like solubility and availability as in these domestic manures he would pay about nine cents a pound, and for nitrogen, sixteen if not eighteen cents; I take the lower figure to be sure that I am within bounds.

How do these prices compare with those actually paid for these plant nutrients in such animal or vegetable manures as gardeners or farmers buy?

Two or three years ago there came to me from a gentleman of this neighborhood a series of questions as to the comparative cheapness of several of these manures. The questions could be answered, at least with approximate satisfaction, since the inquirer was fortunately able to give me the cost per ton, at his own place, of all the materials in question. I had not time to analyze samples of the manures, and for the necessary information as to their composition I had to refer to the tables giving the average composition of such matters; if my estimates could have been based on actual analyses of the materials, they might have been somewhat, but certainly not very, different.

The results of my calculations are set forth in the following table: —

Kind of Manure.	Cost per 1,000 pounds.	1,000 pounds contained of			Cost, in cents, per pound of the		
		Nitrogen.	Phosphoric acid.	Potash.	Nitrogen.	Phosphoric acid.	Potash.
Cow manure,	$1 16	4	1.6	3.6	19.2	10.8	6.0
Horse manure,	1 54	7	1.5	9.5	14.1	7.9	4.4
Night-soil,	43	7	14.0	2.0	2.8	1.6	0.9
Rockweed,	1 21	4	2.3	4.0	20.5	11.5	6.3
Fish-chum, half dry,	6 50	43	50.0	–	9.1	5.1	–
Hen manure,	4 00	10	6.0	5.0	27.0	15.0	8.4
Tanners' waste,	78	72	19.0	–	0.9	0.5	–

If my figures are not wrong, the cow manure is not a cheap source of plant food; it would have to be looked upon as more costly than commercial fertilizers, were it not for the large amount of humus-forming material that it contains; this may offset the high cost of the important plant nutrients in it. But then we have just as much of this humus-forming material in horse manure; and the important plant nutrients in that, instead of being more costly than in the commercial fertilizer, are actually cheaper. The night-soil costs nothing except for the hauling; the plant food in it is remarkably cheap, costing only about a fifth as much as in horse manure; and one can see no reason why a pound of nitrogen in it should not be just as good for crop production as a pound of the same nutrient in horse manure. Rockweed is an expensive manure, much more so than commercial manures, while the plant food in it certainly cannot be any more available or valuable than in fine bone meal, or in good horse manure, or than in the fish-chum, which provides nitrogen and phosphoric acid at half the cost.

Hen manure is another expensive fertilizer: its plant food costs more than that in any other fertilizer, natural or artificial. Even nitrogen in ammonia salts costs only twenty-two cents, and phosphoric acid in the best superphosphate only ten cents a pound. From my point of view I should say that a great deal more was paid for that manure than it was

worth. As to the tanners' waste I had to do some guessing; I took it to be mostly hair and clippings of fresh skins; it cost nothing except for the hauling. If I was right in my conjecture as to its character, it is rich in both nitrogen and phosphoric acid, and is by far the cheapest manure of all; but its action may be much slower than many of the other manures in the list, which would detract from its value. Granting all that, it would still appear to be a very cheap manure.

Making all due allowance throughout these estimates for the possible deviations from the general average composition of such materials, I still affirm that where they come out so widely apart as they do in some cases, they indicate real and undoubted differences in the cost of the plant food, that may be of considerable practical importance to the buyer of such manures.

We may look for a moment, before I close, at this same matter from another point of view. On the University farm at Cornell, Professor Roberts, by a careful system of saving and housing his stable manure, and rich feeding of his stock, largely milch cows, has obtained a product that, analyzed in my laboratory, was found to contain .7 per cent. of nitrogen, .4 of phosphoric acid and .84 of potash. The manure was applied at the rate of ten tons to the acre, which quantity would contain about 150 pounds of nitrogen, 80 of phosphoric acid and 160 of potash. These amounts of three nutrients would cost, in a commercial fertilizer, at the same rates per pound as in the other calculations whose results have been given, about $40; but this ten tons of manure did not begin to cost so much, — it was the waste of the animals producing a revenue by their milk or growth or work. It did undoubtedly cost something, but I think it is safe to say not over $1.50 a ton, or half as much as the horse manure, of which an account has been given above. This would make the plant food in it cost less than half as much as in that manure, and much less than in commercial fertilizers.

It may seem to many that thus far I have spoken only unfavorably of the use of commercial fertilizers; but I would not wish to leave you with the impression on your minds that I regard them with disfavor. On the contrary, I do not

believe we could get along without them in general crop growing; and I see no reason why, if they are judiciously used, they should not do as much for horticulture as they are doing for agriculture. If the farmer succeeds better in getting profitable returns from an investment in a certain quantity of nitrogen, phosphoric acid and potash in a superphosphate than the horticulturist does, it may be because the latter has not learned by experience, as the former has, how to get such returns; and as long as he can procure animal manures by any sort of management, he will continue to use them rather than get out of the ruts and learn how to use something else in place of them. So far as the humus is concerned, on whose apparent usefulness I have dwelt so long, its due proportion in the soil can be maintained by green manuring, and without getting or making much stable manure; or by spreading over the uplands some of the contents of the muck deposits that are to be found on so many farms.

In order, however, to enable these commercial manures to compete with the cheaper plant food in animal manures, they must be bought at such rates, and in such ways, as to reduce the cost of the plant food they contain to as low a point as possible. A comparison of the cost of plant food in mixed fertilizers, such as superphosphate and special manures, with cash prices for precisely the same quality in the raw materials used by the manufacturers for making up these mixed fertilizers, shows that in the last two years consumers have paid from eighteen to twenty per cent. more for the plant food in the former than in the latter, or the raw materials; or, stated in another way, about $33 expended in the raw materials would buy just as much and just as valuable plant food as would cost $40 in superphosphates or specials. These figures represent the *average* difference in favor of getting the raw materials directly; sometimes the superphosphate is sold at such low rates that its plant food is almost as cheap as in any other form in the market; but, on the other hand, the difference is sometimes very much larger in favor of the raw materials. For instance: in one case, a Connecticut farmer was asked to pay, and perhaps he did pay, $45 for a certain quantity and quality of plant food that would have cost him but about $26 in the raw material.

These raw materials are such as nitrate of soda, sulphate of ammonia, dried blood, and dried and ground fish-waste, any of which may be used for charging a fertilizer with nitrogen; plain superphosphate, — that is, without any nitrogen, — for supplying the soluble phosphoric acid; and potash salts for the potash.

A Connecticut farmer tried this home mixing last year, using four tons of dissolved bones, one ton of muriate of potash, and one ton of sulphate of ammonia, making thus an excellent and really ammoniated superphosphate; it cost him, including materials, freight and labor, $36.20 per ton; analyzed at the Experiment Station, it was reported to be worth, at current prices, $45, which was a very much better showing than was made by any one of the fifty samples of superphosphate analyzed at the same station during the year. The consumer had at the same time the great advantage of knowing just what the mixture was made of; that, for example, its nitrogen was in the form of sulphate of ammonia, the most costly and the most valuable form of nitrogenous plant food, and not of roasted and ground leather waste, an utterly worthless form of nitrogenous plant food. Other farmers of that State have done likewise, and with good results also, both in the analysis and in the field.

Instead of closing with some flourish of a peroration, it will, I think, be more in keeping with the character of my lecture if I should sum up in a few words the main points which I have attempted to explain or illustrate: —

1. That if the elements needed for the food of the gardener's or horticulturist's crops cannot be obtained in sufficient quantity from stable manure, or other animal waste, they can be procured in the trade in unlimited quantity and in every degree of availability depending on different grades of solubility; and in the greatest variety of mixtures, so as to suit any whim or fancy of crop or crop grower.

2. That profitable crop growing can be carried on, for many years at least, with these commercial fertilizers alone.

3. That the most evident distinction between stable manure and commercial fertilizers, and the distinction upon which we should, therefore, naturally base an explanation of the greater reliability of the former, is its large proportion

of vegetable matter, or humus-forming material; of which commercial fertilizers contain practically none.

4. That soils contain, in a difficultly soluble condition, and therefore not easily fed upon by the crops, large supplies of all the needed elements of plant food.

5. That humus, through its decay in the soil, furnishes carbonic acid, among other solvent agents; and this carbonic acid appears to play an important part in the nourishment of crops by bringing the native, insoluble stock of plant food within their easy reach.

6. That even if we add water-soluble plant food to the soil it becomes largely insoluble before the crop can feed upon it, or needs it; therefore soluble plant food added to the soil in commercial fertilizers needs also the help of the humus, finally, for its solution.

7. That plant food in most animal and vegetable residues used as manures costs much less than in commercial manures.

8. That, in spite of the disadvantages which, under some conditions, attend the use of commercial fertilizers, they are nevertheless a very important and necessary help in crop growing.

9. That in using these fertilizers the wisest course appears to be to make one's own mixtures of the raw materials, as well for securing a better manure as for economy in first cost.

Discussion.

Professor Caldwell said, in answer to an inquiry concerning his statement that soluble substances are rendered insoluble by being mixed with the soil, that the nitrogen of nitrogen compounds passes sooner or later into the form of nitrates, especially if the soil is permeable to the air. The nitrates leach rapidly from the soil, while the other compounds of nitrogen are not so subject to waste from this cause, and the compounds of phosphoric acid and potash suffer scarcely any appreciable waste.

Hon. James J. H. Gregory was much pleased with the essay, which dealt with the fundamental points of fertilization, and brought in one rescuing fact, — that we can use commercial fertilizers to raise cow-pease or clover, and can

make humus by ploughing these under. Barn manure is what has passed through the animal; the part of the food retained has become a portion of the animal, and manufacturers ultimately make fertilizers of him. Dung differs in its composition from the fertilizer made from the flesh and bones of the animal only in the fact that it is diluted with a larger quantity of water.

A. W. Cheever remarked that ploughing in green crops as fertilizers is practised more in the State of New York than here. A neighbor of his applied commercial fertilizers to a piece of ground, and sowed winter rye, which when nearly ready to blossom was ploughed in as a fertilizer for corn, but proved a failure. The speaker accounted for it by supposing that the rye had absorbed all the immediately available plant food, and did not decay soon enough to feed the corn.

Professor Caldwell thought Mr. Cheever's explanation probably correct. It would have been better to put on a crop later in the season.

William H. Bowker was much pleased with the essay, as well as with other writings by Professor Caldwell, and felt no fear that his occupation as a manufacturer of fertilizers was in danger. It made little difference to him whether he sold the materials of fertilizers for mixing, or mixed them to suit the wants of farmers. There must be a margin of profit, and formerly there was a greater profit on manufactured goods than there is now. It has cost a great deal to work up the use of fertilizers to the present point. No one not in the trade has any idea of the increase; and the speaker could not tell what it would come to in the future. He saw no way to procure the materials that will be wanted for fertilizers, especially nitrogen. He advised that farmers keep more stock and feed better, using artificial fertilizers only as supplementary to barnyard manure. They should study the feeding of animals in connection with feeding the soil. He recommended cotton-seed meal as feed for stock where rich manure is desired.

Mr. Gregory thought it well for farmers to buy the raw materials and do their own mixing. He had done so and knew the inside of the business. The margin which had

been referred to as necessary was due to several causes: manufacturers have to hold their stocks two years; bags cost something; there is much waste, and agents are expensive, but we are indebted to them for stimulating farmers to purchase. We ought to allow a little leeway, — say three or four dollars per ton. We have hardly done justice to the manufacturers and dealers, but have made them the target for complaint and abuse on account of failure.

Professor Caldwell thought there was a difference of eighteen or twenty per cent. against mixed fertilizers as compared with the raw materials, estimating the latter at cash prices. Manufacturers sell on time.

William H. Hunt was pleased with the careful statements of the essay. The cost of stable manure was estimated at less than it costs here; it would be nearly one-half more here. He thought one of the greatest advantages in using artificial fertilizers is the ease with which they are applied in the growing season, when farmers are too busy to put on stable manure. They can be put on very rapidly. They have also a great advantage for remote fields, the expense of applying them being so much less than that of applying stable manure as often to make the practical difference between planting and not planting a crop. Fertilizers can, however, be used to the best advantage in connection with stable manures.

Samuel Hartwell was surprised at the low value placed on hen manure by Professor Caldwell. The New England Agricultural Society had lately held two elaborate discussions on poultry, and all considered the excrement a very valuable fertilizer; it was supposed to resemble guano. He buys horse and cow manure at the same price per cord, and, considering the greater weight of the latter, thinks it more valuable, cord for cord.

Professor Caldwell said that guano is the dried and concentrated dung of birds fed on fish, and is much richer in plant food than the ordinary droppings from fowls fed on grain.

Mr. Cheever asked Professor Caldwell's opinion as to the economy of attempting to improve lands by ploughing in green crops, either here or in New York. Can we afford

to raise clover, rye, and other crops for ploughing in, with the supplemental use of commercial fertilizers? He had taken the ground that it was bad management to do so; and preferred to feed the crops.

Professor Caldwell did not think green manuring an economical process: it takes time; and it is better to put the crop through the animal, where stock feeding is at all profitable. Animals retain only ten per cent. of the food they consume. Clover would be least profitable of all crops to plough in, because it is so good for fodder; it is too good to plough in. When cut it leaves a great deal of fertilizing material in the stubble and roots, and is an excellent preparation for wheat. He advised the ploughing in of green crops only when they cannot be used for fodder. He did not pretend to stand here as a judge of manures; but the nitrogen in the hen manure did cost twenty-seven cents per pound. Ammonia in the form of sulphate or nitrate would have cost only twenty-two cents. There is a great difference in the quality of hen manure; some is taken better care of than others.

Mr. Bowker said he had heard a great deal of talk about applying the South Carolina phosphate directly to the soil in a finely ground state, without rendering it soluble, and asked Professor Caldwell's opinion of it.

Professor Caldwell replied that very few careful experiments had been made with the South Carolina phosphates. In Europe experiments have been made with such mineral phosphates as they have there, and the results have not been favorable; but those found in South Carolina are of better quality. Writers using the term "South Carolina phosphates" sometimes mean superphosphates made from them. Superphosphate containing phosphoric acid in a soluble or reverted state has a very great advantage over the mineral, in the ease with which it is dissolved and distributed in the soil.

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